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POWER

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JANUARY, 1938

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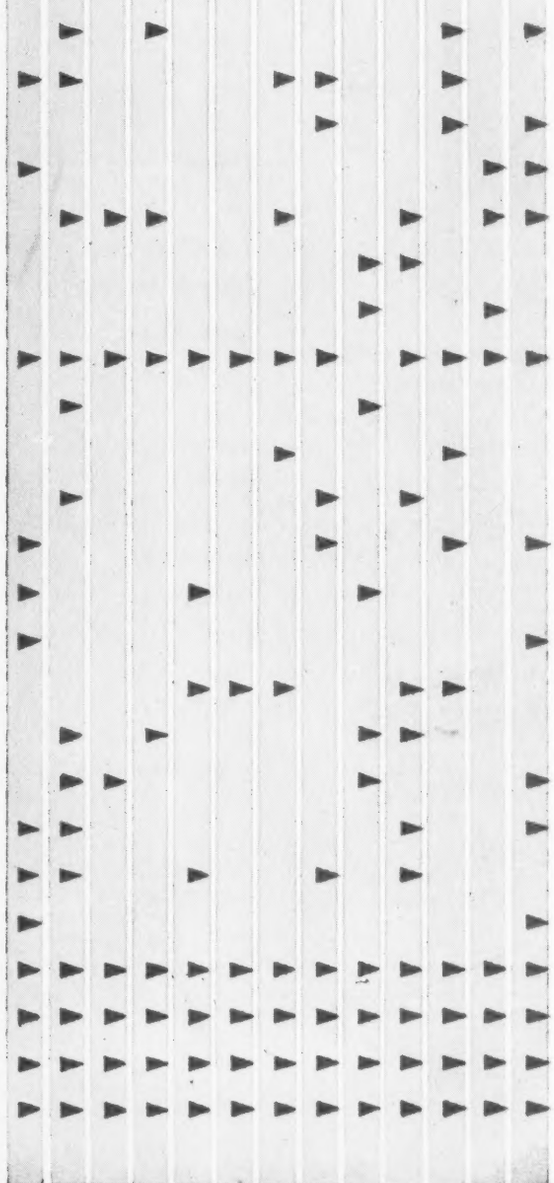

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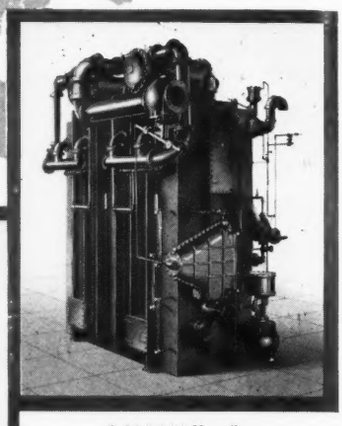
A Measure of Cochrane Performance



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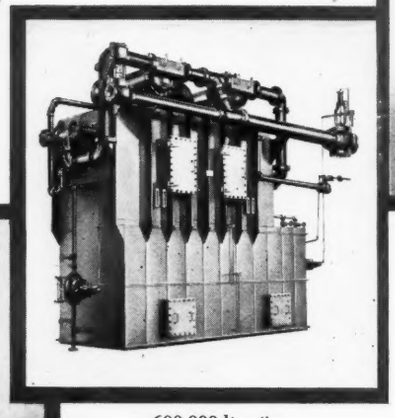

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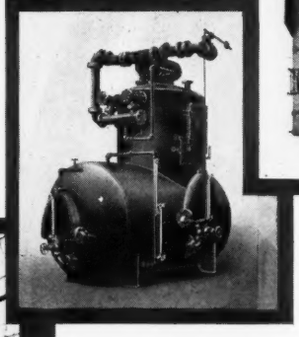

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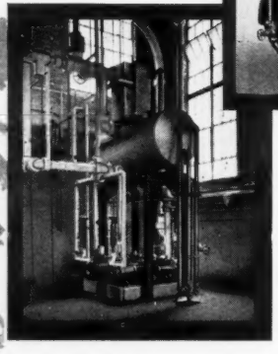

36,000 lbs./hr.

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COCHRANE has furnished heating and deaerating equipment with capacities exceeding 25,000,000 h.p., which is greater than the total steam generated horsepower in the United States (23,400,000). These installations—made over the period of years dating from 1885, when Cochrane introduced to industry the first open type feed water heater—attest Cochrane leadership and guarantee to each user:

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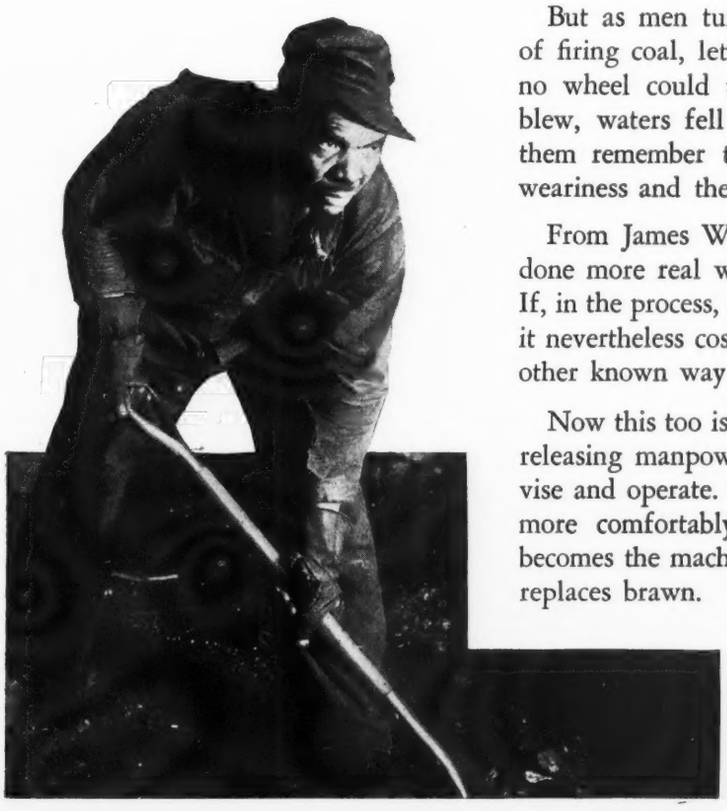
WATER SOFTENERS • DEAERATING HEATERS • DEAERATORS

POWER
ESTABLISHED 1882
PHILIP W SWAIN *Editor*

REST IN PEACE



NOT LONG HENCE this picture will belong in the engineer's memory book. The shovel passes. May it rest in peace, whether embalmed as a nickle-plated museum specimen or rusting in solitude on some desolate dump heap.

But as men turn from the shovel to better ways of firing coal, let them never forget the days when no wheel could turn unless animals pulled, winds blew, waters fell or toiling workers shoveled. Let them remember the sweat and dust, the heat, the weariness and the aching shoulders.

From James Watt till now, shovel-borne coal has done more real work than all the slaves of history. If, in the process, some men were slaves to the shovel, it nevertheless cost far less in human effort than any other known way of getting the work done.

Now this too is ended. Machines lift and fire coal, releasing manpower to control and direct, to supervise and operate. Man's work grows easier; he lives more comfortably. The coal heaver of yesterday becomes the machine operator of today. Brain again replaces brawn.

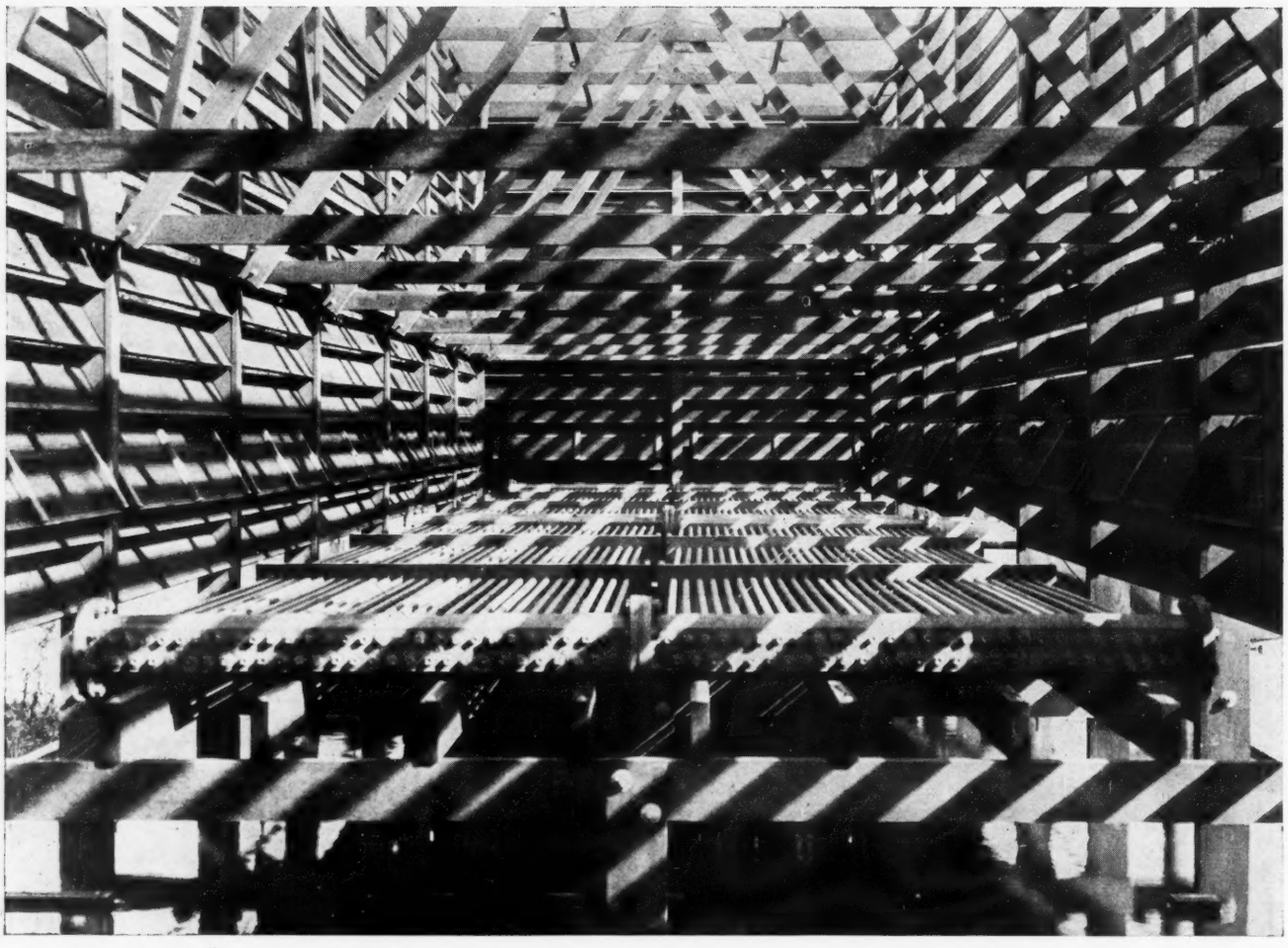


Fig. 1—Interior view of spray-tube cooling tower with atmospheric-tube heat exchangers in base for closed system

When Does It Pay to Use
CLOSED DIESEL COOLING

Closed cooling eliminates scale and saves more than 90% of water. Professor Bischof shows how to determine when and how these savings justify the higher first cost

By Gustave J Bischof

CONS ENGR, THE COOLING TOWER CO, INC; ASST PROF MECH ENGRG, SCHOOL OF TECH, COLLEGE OF THE CITY OF NEW YORK

A CLOSED COOLING system may be defined as one in which the cooling water is continuously recirculated in the closed engine circuit and cooled by transfer of heat to air through radiator walls or to raw water through heat-exchanger walls. In a closed system, the jacket water is soft, and any addition to this water to replenish slight leakages is also soft. An open cooling system is one in which the jacket water is either run to waste or recirculated after passing over a cooling tower in direct contact with air.

An open cooling system, even if originally filled with soft water, will progressively concentrate salts as hard water is added for the considerable make-up requirements. The salts tend to deposit in the engine jackets as scale, forming an insulating coating which prevents heat transfer from cylinder to water. In time this deposit, unless periodically removed, causes overheating, resulting in cracked castings or breakdown of lubrication.

There are many possible forms of closed cooling systems. The particular selection which proves best for a certain engine installation is governed by the specific conditions of the job. It can only be recommended after complete study of the project and such items as the size of plant, load variation, allowable off engine temperatures, jacket design and general operating characteristics, including possible use of cooling water for building service or boiler feed. For the smaller installations, especially portable ones and

those in the basements of large office buildings, the water-to-air type of closed system employing fan-cooled radiators often proves convenient and economical; the only drawback being the comparatively high fan power consumption and the necessarily high jacket-water temperature. Where unlimited quantities of water of poor quality are available, the raw water may be run to waste after cooling the soft jacket water through a heat exchanger.

The more-usual arrangement in medium- and large-sized plants is to recirculate raw water through a heat exchanger and over a cooling tower. This saves approximately 95% of the raw water. With the cooling tower, either atmospheric tube exchangers, directly in the base of the tower under the falling raw water, or shell-and-tube exchangers inside a building, may be used. Open systems (without heat exchangers) can only be used economically and safely, as will be seen further on, in the comparatively infrequent cases where there is available water of very low hardness or with accessory water-softening equipment.

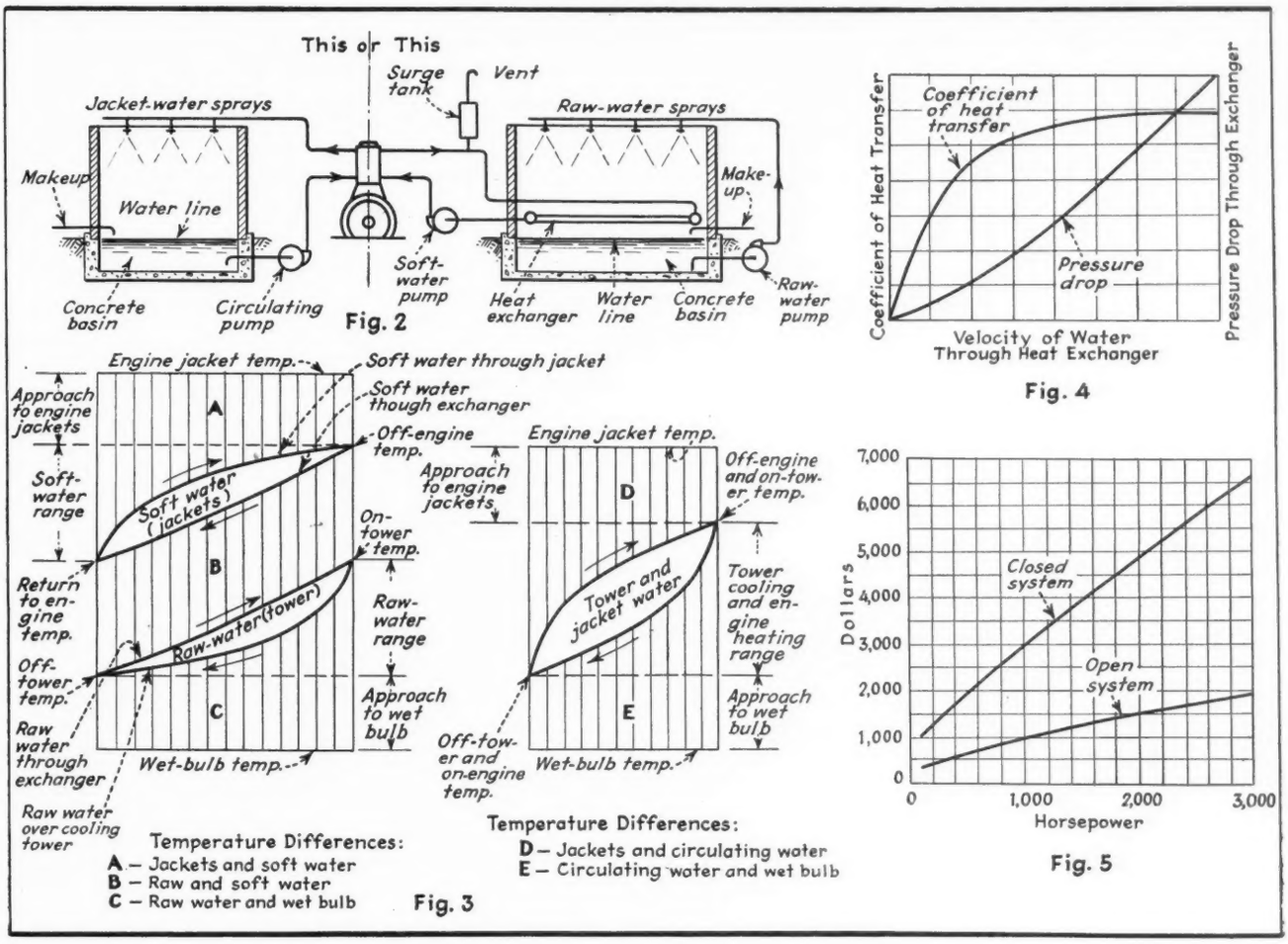
Inherent differences make the closed system more expensive to install than the open. Besides the cost of heat exchangers, there is the added cost of an additional pump for raw-water circulation. The cooling tower is also larger for the closed system, because raw water is cooled to a lower temperature in order to maintain a sufficient temperature difference for the added heat-transfer step through the heat exchanger. The schematic heat-flow diagram, Fig. 3, makes clear the heat-transfer difference between a closed system with heat exchangers and an open system. Fortunately the soft jacket-water system, being free from scale-forming salts, may be run at higher off-engine water temperatures than the open system in which scale-formation dangers increase at the higher temperatures. Indeed, higher temperatures are generally advantageous from an operating standpoint in that they permit more efficient utilization of diesel fuel. The bare essentials of both an open and closed cooling system are shown in Fig. 2, which illustrates the additional equipment necessary for the closed type of cooling.

Regardless of whether an open or closed system is used, the heating and cooling range of the jacket water is best kept at a maximum of about 20 F and sufficient water circulated to take care of the heat dissipation, which varies from 2,500 to 3,500 Btu per hr per b hp (depending on characteristics of the engine and whether it has exhaust manifold cooling and piston cooling). Higher ranges increase heat stresses in the cylinders, and the accompanying decrease in circulation reduces jacket-water velocities, resulting in stagnant pockets where steam may form and solids deposit.

Temperature Reduction

Still further reduction of the jacket water range to 15 F, or even 12 F in closed systems, usually proves economical despite larger water quantities handled. The larger water quantities increase velocities (and hence turbulence) within the heat exchanger, hence, up to a certain point, induce greater heat transfer per unit of surface. An economical limit from this angle is soon reached, however, due to the decreasing increments in the coefficient of heat transfer and the in-

Fig. 2—Diagrammatic water flow for open and closed systems. Fig. 3—Schematic heat flow diagram for closed and open cooling systems with cooling towers. Fig. 4—Variation of coefficient of heat transfer and pressure drop with velocity. Fig. 5—Installation costs for open and closed systems



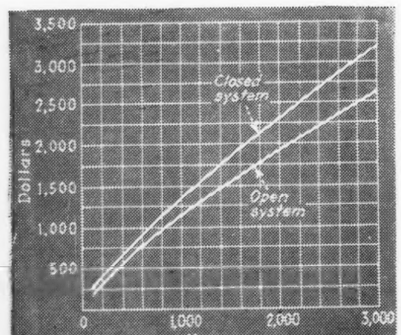


Fig. 6

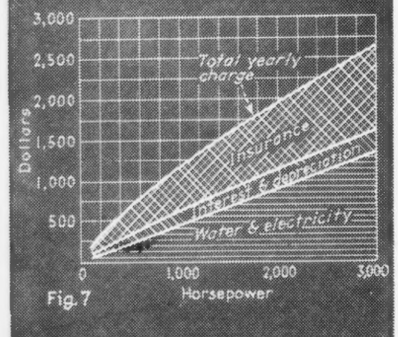


Fig. 7

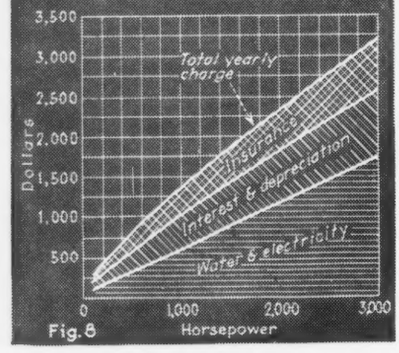


Fig. 8

Fig. 6—Total yearly charges for open and closed systems. Fig. 7—Total yearly charge components for open systems. Fig. 8—Total yearly charge components for closed systems

creasing increments in frictional resistance as velocity increases. In Fig. 4 are shown the characteristic curves of pressure drop and coefficient of heat transfer varying with velocity in heat-exchanger tubes. Lower ranges for both soft and raw water, accompanying increased circulations at definite heat dissipations in closed systems, is also the only possible way to increase the mean temperature difference (*B*, Fig. 3) between raw and soft water, the upper limit of off-engine temperature and the lower limit of wet bulb being fixed by location and the particular engine.

The trend, in recent years, is definitely to the use of closed systems. Is this trend justified and to what extent can the factors underlying the choice be evaluated? Total yearly charges associated with the existence and the operation of the cooling system are generally regarded as the proper criterion of economy. The item of original investment, with consequent fixed financial charges and operating charges for the cooling system itself (such as pump power and water), lend themselves to routine evaluation. A competent plant designer, with the help of equipment engineers, can come to a fairly accurate conclusion. Such a conclusion, based on these items alone, would always be in favor of an open system.

Less-Tangible Items

To complete the picture, however, there must be some attempt at comparing other less-tangible items reflecting the operation and maintenance costs of the engines themselves. Operating engineers know the expense of periodically descaling jackets, and the worries of interrupted service. Executives are familiar with high replacement costs of cracked cylinder heads, seized pistons and the more far-reaching damage resulting from interrupted power supply when an engine fails. There seems to be no generally available data on what these expenses are per year, and furthermore they vary with the character of the water used. A closed system will of course result in generally improved operation and lower maintenance. A clue to the lower upkeep of installations so equipped is the substantially lower insurance premiums charged for closed systems as against those for open systems. Premiums are based on figures embracing the experience of a great many installations and are divided into four classes, namely: older and newer engines and those equipped with either open or closed systems. These premiums appear to reflect the relative risks involved.

To put yearly total charge comparisons for open and closed systems for various sized engines into concrete form, the following study was made and the results are given graphically. Closed systems for installations from 100 to 3000 b hp are considered. Fig. 5 shows investment costs for open and closed cooling systems. The costs do not include those piping and accessory items, which are substantially the same for both systems and would even be required for a simple city-water cooling system run to waste. For the open system, they include a proper-size spray cooling tower, a concrete ground basin and a circulating pump and motor, all installed with open-shop labor and of capacity to cool the circulating water from 115 F to a return of 95 F under 75 F wet bulb. The closed system investment comprises a spray tower with atmospheric tube heat exchangers in base (see Fig. 1), a concrete ground basin and two circulating pumps with motors (for soft- and raw-water circulation), all installed and of capacity to cool the soft water from 140 F to 125 F return under 75 F wet bulb. The cost per brake horsepower for the open system varies from $4 for small sizes down to $0.70 for large installations. The cost of closed systems varies from $11 down to $2.40 per b hp, decreasing again with size. The closed system therefore represents an investment of approximate three times that of the open system. Total yearly charges are given for both types in Fig. 6 and show the charges for closed systems to be approximately 20% to 30% greater than those for open systems.

Total yearly charges are composed of investment charges, operating charges (pumping cost and makeup water) and insurance. Investment charges as taken are based on 5% interest on installation cost and yearly equalized depreciation payments for 10 years into a sinking fund compounded annually at 5% interest. The operating charges assume 3,000 hours operation per year and makeup water costing $1 per thousand cu ft and electric current at $0.01 per kwhr. The insurance rates are based on engines built after 1925, paid in 3-year premiums and are the so-called "objective charge" to which is added a small insurance charge (not included).

Costs Similar

It is of interest to note the relative sizes of these three components as analyzed in Figs. 7 and 8. Actual curves would show a stepped character as the engine installations became larger, but all curves shown have been smoothed out for convenience. Fig. 7, dealing with open systems, shows the investment and operating components as small, but with a large insurance component. Fig. 8 for the closed system, on the other hand, indicates relatively large yearly investment and operating charges (due to high initial cost and double pumping) and low insurance charges. In other words, the open system costs less in itself but introduces greater engine hazards. While the installation cost of an open system and its operation (water and current) are both decidedly lower, insurance rates for the engine are higher and bring total yearly charges associated with an open system to within 80% to 85% of those with a closed system.

At first thought, the comparative study results alone seem to favor the open system. This might be true insofar as insurance premiums reflect engine part replacement costs. They cannot, however, reflect the higher labor maintenance costs and the money value of the interrupted service haz-

ards. These largely depend on the systematic care and method of operation, (with possibility of water-softening equipment) together with actual hardness of water available for cooling, and if these items were added to open-system charges, they may generally be supposed to more than swing the balance to the closed system.

While the study cannot be considered conclusive and is based on only one type of closed and open cooling system, it does show a very real basis for believing the trend to closed systems justified. It is intended, furthermore, as an approach to an inclusive method of evaluation which may be used as an investigative tool for each type of job in which many local and particular circumstances rightly deserve consideration.

Exhaust Lines

By E J Tangerman

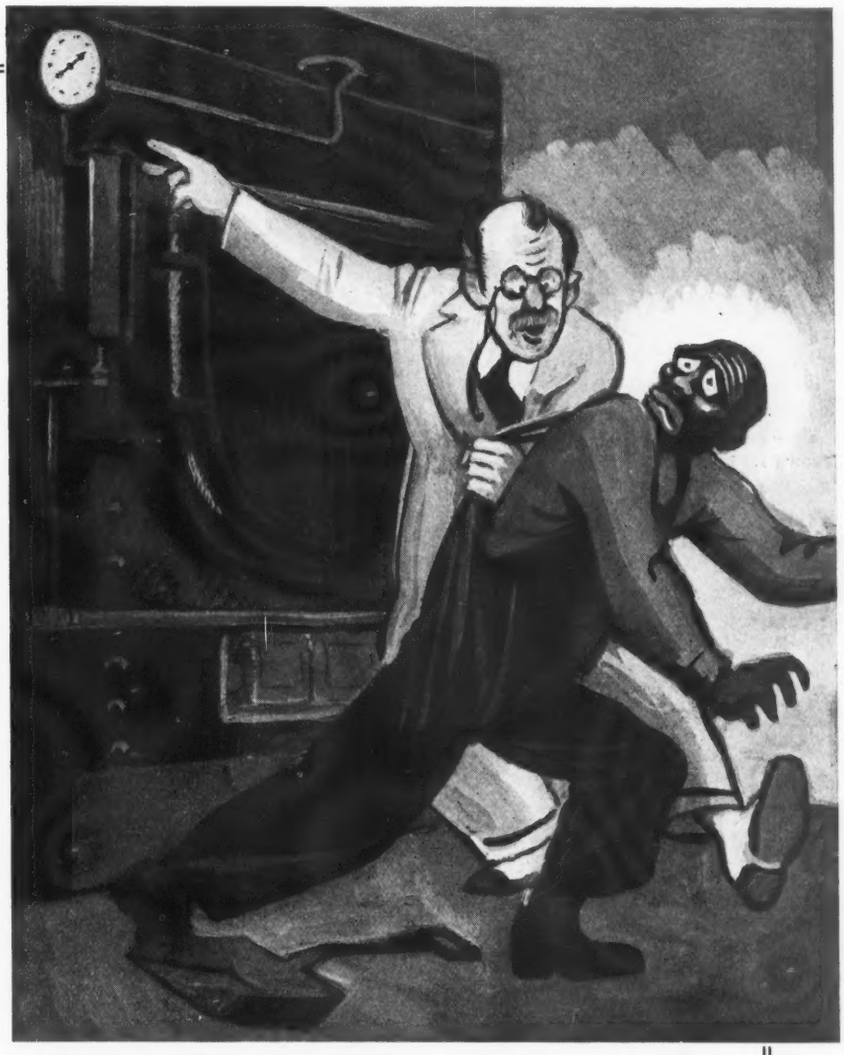
The basic principle of the diesel or compression-ignition engine was known by the savages in Burma and Samoa hundreds of years ago. They used it in their fire lighters, which were like nothing so much as a bicycle pump with the hose crimped so that the air can't get out. They put a little dried moss or other combustible on the end of the plunger, entered the plunger in the barrel, and snapped it down with a sudden, hard blow. The resulting air compression inside the barrel raised the temperature of the air sufficiently to ignite the combustible, so when the plunger was withdrawn it was glowing and had only to be fanned into flame.

In Boston, the district steam set-up is unusual in that condensate from the steam system is used for hot-water services in several of the buildings served, instead of the normal steam heaters.

Fire-fighting is a complex problem. The latest yarn comes from Greenville, Ala., where the local fire department, fighting a fire in cotton bales in a warehouse, used kerosene instead of water. The fire was smouldering deep down inside the cotton bales where water wouldn't penetrate, while kerosene would. The shortage of air at the fire meant that any kerosene fumes generated could not burn, so the kerosene did water's job better than water could—in that one case.

Students at Punahou School, Honolulu, have built the largest solar water heater, covering 308 ft of roof area and containing 1400 ft of copper tubing.

About 42 years ago, there were only 4 automobiles in the United States. Now there are 27 million, and it is estimated that by 1960 there will be 31 million. At 50 hp per vehicle, there are now 1,350,000,000 hp—one and a third *billion* —in cars, about ten times as much as there is in stationary power plants, but annual horsepower-hours of stationary plants is at least ten times higher due to greater load factor and more constant operation.



"Ah knows it only show' 60, Boss, but what you doan' know is that han's bin aroun' twice befo' a'ready!!"

It took a church and a saloon to inaugurate 24-hr electric service in Buffalo. Robert W Emblidge, 67-year-old superintendent of operations for Buffalo Niagara Electric Corp, recalled recently as he completed 50 years of service with the company, that in 1893 the St. Paul's Cathedral was wired for lights, requiring Sunday electric service. Shortly thereafter, Johnny Woods' saloon was wired for 24-hr service.

Within the next five years, Russia is planning to build five power stations in which shale is to be burned to raise steam. Two such plants are already in operation, one on the Volga and the other at Leningrad. The seven will total 530,000 kw.

Dr. H H Storch and his colleagues at the Bureau of Mines reported recently to the American Chemical Society that they had succeeded in converting 84% of Pennsylvania coal into a liquid similar to petroleum, which can be refined into approximately equal quantities of light and heavy oils. Their tests were with 100-lb lots, but it could be done commercially.

Leave it to me to say the wrong thing at the right time. Helping Kellogg Corp to get a tank from New Jersey to Whiting, Ind., by water, I took the tank up through the Soo, forgetting that that leads to Lake Superior, not Lake Michigan. I was thinking of the Straits of Mackinac, honest Injun.

On the Line at Montville

Starting period for new 25,000-kw condensing unit attended by only minor troubles. New 650-lb, 825-F boilers and turbine have no interconnection with low-pressure station. Feedwater is stored under vacuum

By S A Tucker
ASSOCIATE EDITOR

JUST AT THIS TIME a number of new central-station installations are in the early stages of commercial operation. Tops are getting most of the attention because there are more of them, but the art of exhausting steam to a condenser has not been lost. At Montville, Thames River Steam Station of the Connecticut Light & Power Co, the new unit, a 25,000-kw, 3600-rpm turbine and air-cooled generator, is already in everyday operation with most of the little kinks ironed out. Such troubles as have occurred have been run-of-mine, as attested by the short period of trial operation, about two months.

Complete independence of the new unit from the older part of the station makes Montville different from the many other new installations closely connected to existing plant. Such ties are inherent in the idea of superposition. Interconnection with hydro permits shutting down the low-pressure plant at night when stream flow is adequate, leaving the new unit as principal standby and putting a premium on its almost continuous availability. Every part of the design has been directed toward simple, safe operation to satisfy these standby requirements.

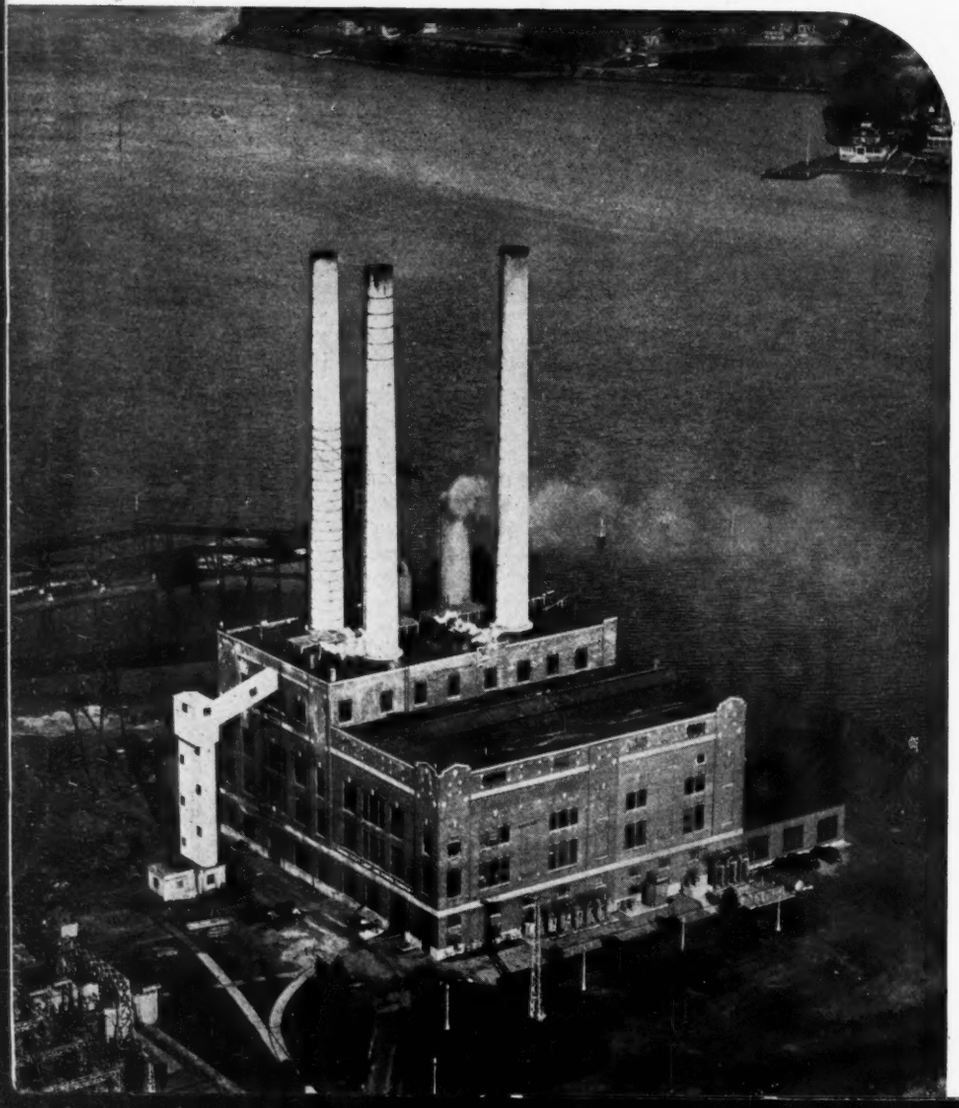
Here are some of the features of the plant that have proved themselves good ideas at Montville, and are possibly suitable elsewhere too. First, the boilers have been supported on existing columns with only a small amount of bracing added. Economy was attained here another way also, because only a short steel stack could be carried on the columns originally intended for a concrete stack but less boiler weight. The new stack is only 50 ft high above the roof, older concrete ones are 160 ft. The non-urban character of the surrounding neighborhood permits a short stack and no mushrooming of gas has been found. The stack could be extended upward 25 ft more, but operation has already shown the extension not needed. Stack plates are seal welded inside and out, so that seams do not collect moisture and corrode. There is no lining.

A dust collector was installed on the roof ahead of the induced-draft fans. Each collector has a primary concentrator stage and a secondary highly-developed form-of-cyclone stage. About 85% of the gas is discharged axially; the remainder shaved off the volute casing for passage to the secondary stage. The primary is equipped with an inlet-control damper operated by the boiler-control system, throttling at fractional loads to maintain uniform rim velocity.

Forethought for erection and for future maintenance has resulted in two open wells in the boiler room from truck platform to fan floor for hoisting equipment.

The two boilers are rated at 130,000 lb per hour each but have done more when required. Coal handling, from bunker to burner, is individual for each of the four burners without interconnection. Full capacity can be developed by three burners but a fuel-oil system, for starting use, can supply approximately half burner capacity in event of trouble with coal supply.

Fig. 1—On the Thames River eight miles above New London, is Montville Station of the Connecticut Light & Power Co.



Fuel-Oil Starting

This emergency fuel-oil system, by the way, was installed mainly for use during the initial starting period and has already more than paid for itself. Since no great quantity of oil is burned and oil cost is not a serious factor, No. 4 domestic fuel is burned without preheat. Experience has already been obtained when a mill supply was interrupted due to packed coal; oil was immediately turned on, carried load until the mill could be returned.

Combining labor saving and safety, boiler stop valves are motor operated. In the remote chance of serious trouble outside the boiler proper (well understood by those who have seen steam on the loose inside a building), the operator can push the closing button in the split second before he has to run. To guard against mistakes in normal operation, the limit switches are set so that the valve disk must be

raised approximately ¾ in. off its seat by hand operation before the electrical circuit supplying power for the opening operation can be energized.

Another indication of forethought for maintenance saving, a power-operated safety valve is connected to a branch of the main steam line and set to blow 25 lb lower than any of the usual safeties at the boiler. All the code requirements are observed by valves on each boiler but the wear and tear is taken on the power-operated valve, closely set as to blow-down. The valve can be isolated from the steam line for maintenance by closing a gate valve in the branch without interrupting operation.

Welded Steam Line

The main steam line is welded carbon-moly with Sarlun joints at boiler and turbine connections. The entire line drains toward the turbine room and terminates in a forged cross. One arm of this cross supplies the auxiliary oil pump, the other, air ejectors. Bottom connection leads to a trap which normally collects nothing and therefore is permitted to discharge to the atmospheric relief pipe. Safe, simple drainage at no actual loss of economy.

Somewhat unusual is the location of air ejectors for the condenser on the turbine-room floor. The simple explanation is lack of space below, but operators now like having control of jets convenient to turbine for starting.

No city-water supply is available; wells furnish makeup to the evaporator. Need for oxygen-free supply of evaporated water led to the installation of two 4000-gal flat welded tanks below the condenser and generator for storing water supply at condenser vacuum. Ample cross connections at the top and bottom insure equal water level in the two tanks. A 12,000-gal emergency supply of distilled water is available from a remote tank. This storage capacity is only used when a boiler is filled.

Heater drips cascade through four feedwater heaters and a drip cooler, then are trapped to the condenser. This arrangement incurs a slight loss in economy but saves the cost of a pump and ensures no oxygen entrance at heater-condensate pump glands.

A small amount of boiler-drum water is recirculated through the feedwater system, entering at the boiler-feed-pump suction, to maintain desired pH value in feed lines. Electrolytic resistance measurement of boiler-feedwater condensate, etc, is recorded on the turbine-room floor. Absolute resistance value means little, but variation from normal indicates carryover from evaporator or loss of boiler-drum-water recirculation or some abnormal condition to be investigated. When boiler-feed-suction pressure falls below normal and stays low for five seconds, a pressure switch trips the breaker shutting down the pump before damage occurs. Other than this there are no overload cutouts in the supply to motor-driven auxiliaries; no steam-driven auxiliaries are used.

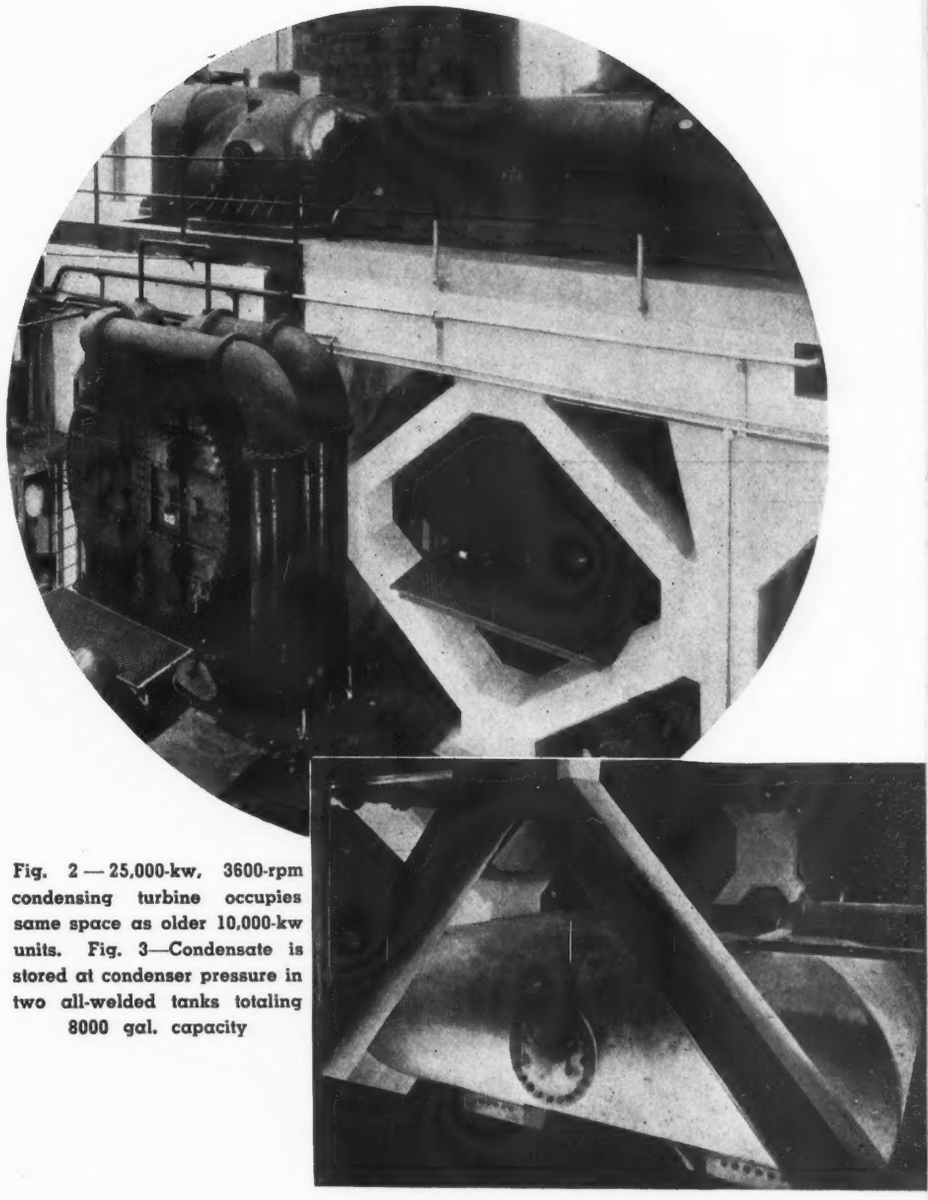


Fig. 2 — 25,000-kw, 3600-rpm condensing turbine occupies same space as older 10,000-kw units. Fig. 3—Condensate is stored at condenser pressure in two all-welded tanks totaling 8000 gal. capacity

The auxiliary oil pump and oil-storage tanks are located away from the turbine in a separate fireproof room. In addition to lubrication and governor systems, pressure oil ensures closing of bleeder nonreturn valves if throttle trips or heaters flood.

Another idea we haven't heard of before is that the Company's refrigerator-service department was called in to install the large amount of tubing required in connection with the automatic-combustion control. Experienced at making customers' plants neat and serviceable, these specialists have kept the many copper tubing lines out of harm's way, and made them look as if they belonged in the boiler room instead of being an afterthought.

An early and about the only turbine trouble to date was an air leak that defied detection but lowered condenser vacuum at irregular and indefinite intervals. A stainless-steel bellows-type expansion joint for leak-off from the dummy-balancing piston was found to have failed for no apparent cause. A replacement joint failed in 24 hours due to fatigue, reasoned to come from vibration induced by the high velocity of steam through the joint. Closely fitted telescoping rings were installed inside, and the joint is still in service.

The plant designers confessed to us that it was a great temptation all through the engineering stages to make some interconnection with the older plant. Once started, the interconnecting habit is hard to stop. Having said that reliability is best served by an independent Montville unit, no ties were allowed. We checked; there aren't any.

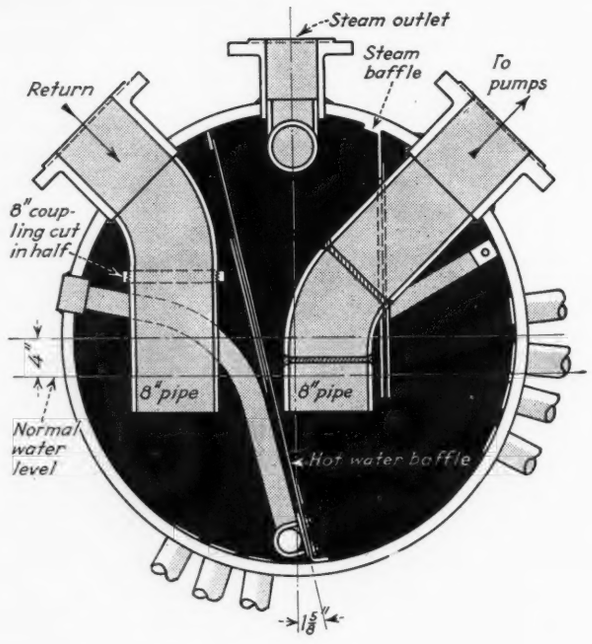


Fig. 1—Process water is drawn directly from the drums of ordinary steam boilers and returned to the same drums. Drawing shows water connections

Superheated Water

A revolution in process heat

General Electrics' new Pittsfield plastic molding plant, world's largest, heats all press molds with 370-F water pumped directly from steam-boiler drums

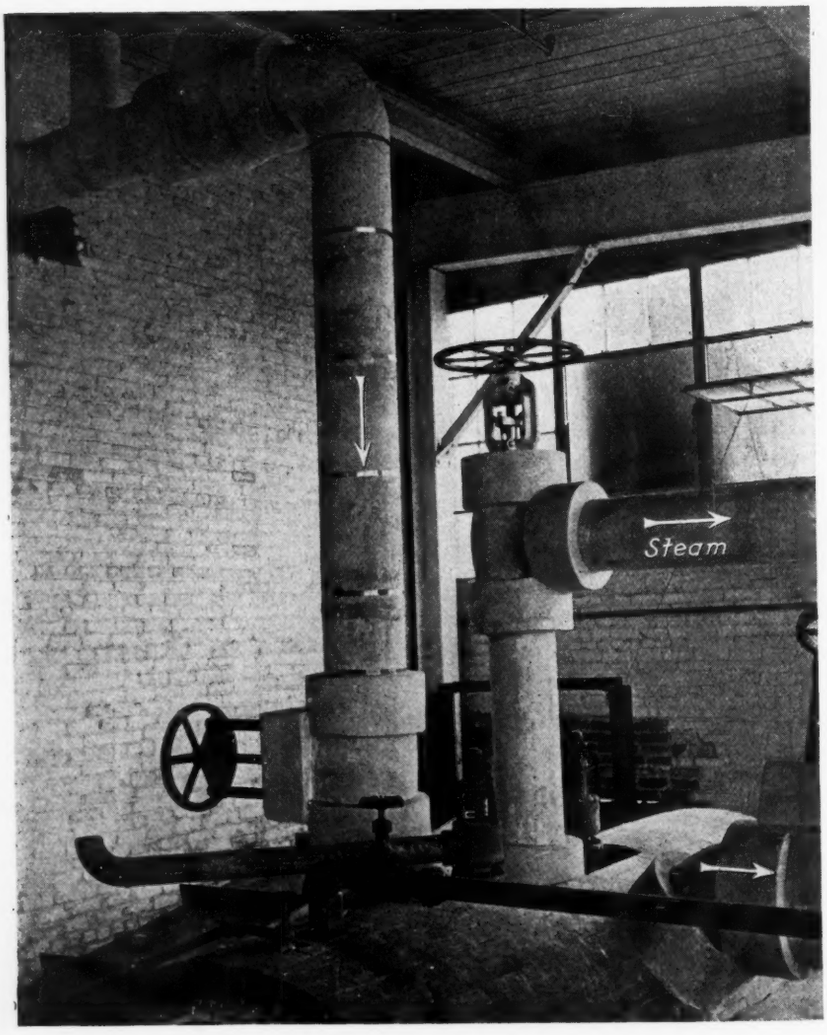


Fig. 2—Boiler top showing process-water connections to steam drum (outlet, extreme right; return, left)

THIS ARTICLE DESCRIBES a revolutionary method of heating plastic molds, in operation since August 1937 in the new General Electric plastic molding plant at Pittsfield, Mass. About 6,000,000 Btu per hour are supplied to the 324 presses by hot water exclusively. And this water, for the first time in any American plastic-molding plant, is applied at a temperature far above the atmospheric boiling point. Widely used in Europe, this system of "superheated" water for process has been applied only once before in America. Advantages claimed include smoother operation, better product and a 30% fuel saving. Based on its successful use in this, the world's largest plastic molding plant, it is expected that this method of supplying process heat will find many other applications in such industries as plastics, rubber, chemicals, food, textiles and paper, and also for space heating.

Water at 370 F

Commercially known as the "supertherm" system, the installation was made by the J O Ross Engineering Corporation of New York. Its novel feature, of course, is not merely the

use of hot water, but its use at temperatures above 212 F.

As shown in Fig. 1, the process hot water is drawn directly from the drums of steam boilers and returned to these drums after use in a completely closed system. Except for these connections, and a water level higher than usual, the two boilers are normal steam generating units. They are Type H Stirling boilers, oil fired, and supply steam for space heating and power plant auxiliaries, as well as process hot water. Each boiler, considered as a steamer alone, has a maximum continuous capacity of 20,000 lb per hour at 200-lb gage pressure.

Direct from Boiler Drum

At extreme right and left, respectively, Fig. 2 shows hot water outlet and return connections to boiler steam drum with steam takeoff between. At top, just left of check valve, may be seen one air chamber. This is vented to a valve at floor level. The entire system contains about 12 such air chambers at high points. These are vented daily. Fig. 3 (in boiler room) shows how a mixture of drum water and press-room returns (hand controlled for correct temperature) is fed to each of the two motor-driven circulating pumps. Pump-suction pressure is 170 lb, outlet 200 lb. Measured in boiler room, the temperature differential ranges from 8 to 12 F, water leaving the boiler room at 370 F and returning at from 358 to 362 F. Water transmission system is all welded and completely "closed." Piping sizes range from 12-in. headers down to 4-in. branches.

Two circulating pumps, each of 500,000-lb-per-hr capacity and driven by a 40-hp motor, allow for future plant expansion. At present only one pump is needed and actual power consumption is less than 20 kw.

Provision has been made for an ultimate installation of 4 pumps to handle a total of 2,000,000 lb per hr, equivalent to a heat delivery of about 20,000,000 Btu per hr.

Fig. 4 shows cross section of a typical mold. Water passages (drilled holes) in upper and lower molds are connected in series by $\frac{3}{8}$-in. (id) flexible metal hose with pipe-threaded ends. For large molds parallel connections are used.

Safety Features

In the opinion of G E engineers, the great mass of 370-F, 200-lb-pressure water in the long mains constitutes no greater hazard than 200-lb steam. In the mold connections, they say, the hazard is less than with steam. For example, when a hose connection was sheared recently by an error in press starting, the resulting water jet struck a man 6 ft away without causing injury or even discomfort. Apparently the flashing of water into steam breaks the force of the jet and cools the water to 212 F. The water is thereafter cooled below the scalding point in the course of its 6-ft trajectory.

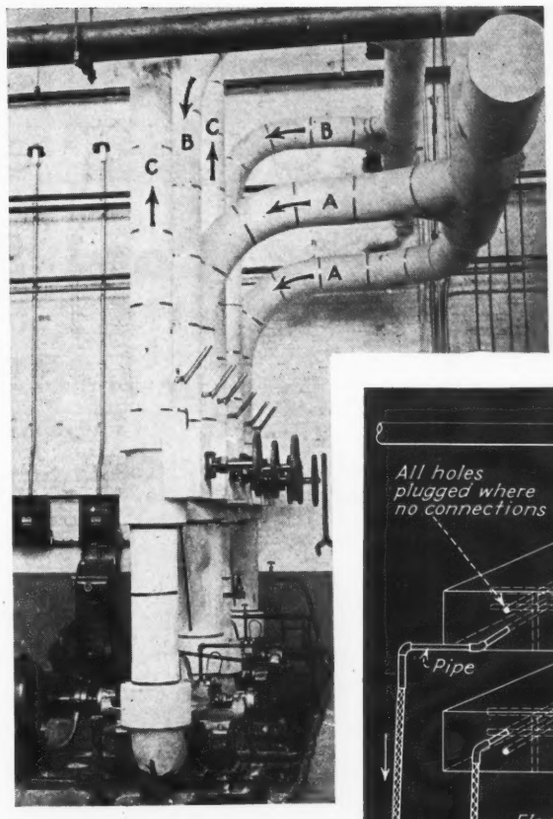


Fig. 3—Valves control supply of boiler water (A) and press returns (B) to pump, delivering to presses through lines C

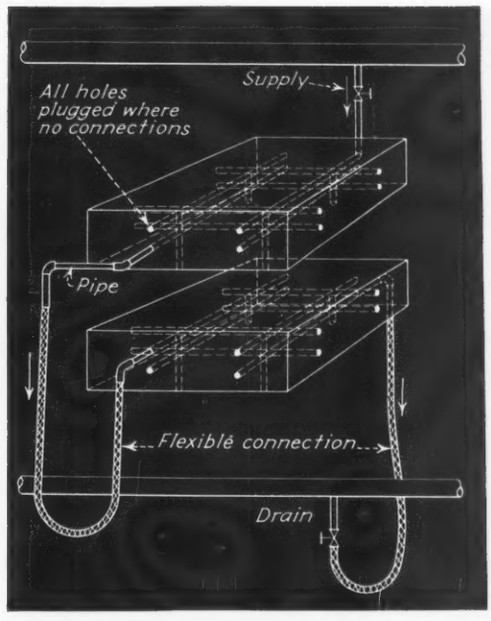


Fig. 4—Typical mold perspective showing water connections

Saves 30%

The water system, at least as installed at Pittsfield, is somewhat more costly than a steam system of equal capacity. Advantages include elimination of traps (and hence of flashing loss and trap leakage), reduced venting for air removal, more even mold heating. Fuel saving is about 30%.

Aside from its "supertherm system," the Pittsfield plastic plant has many features of general interest. Devoted exclusively to research, development, design, and manufacture of molded plastics products, it represents an investment of about a million dollars.

The manufacture of plastics parts by General Electric started over 40 years ago with the production of a few component parts for use on G E products. With tremendous increase in the use of plastics parts has come a growth of similar proportions in General Electric activities in this field, until the business, including molding for outside customers, has trebled within the last five years.

Plastics headquarters, as set up in Pittsfield, include at present about 1000 employees, with additional plants at Lynn, Mass., Meriden, Conn., and Fort Wayne, Indiana.

324 Presses at Pittsfield

At present 324 presses are set up in the new Pittsfield plant. Including branch plants at Meriden and Fort Wayne, there are about 600 presses, by far the largest number operated by any single molder in the country. Molding pressures ranging from $7\frac{1}{2}$ tons to 1500 tons are available in this group of machines.

The editor of *Power* visited the Pittsfield plant in December to study the process-water system. Illustrations and data presented here were obtained through the courtesy of A G Sanford, plastics-construction engineer for General Electric.

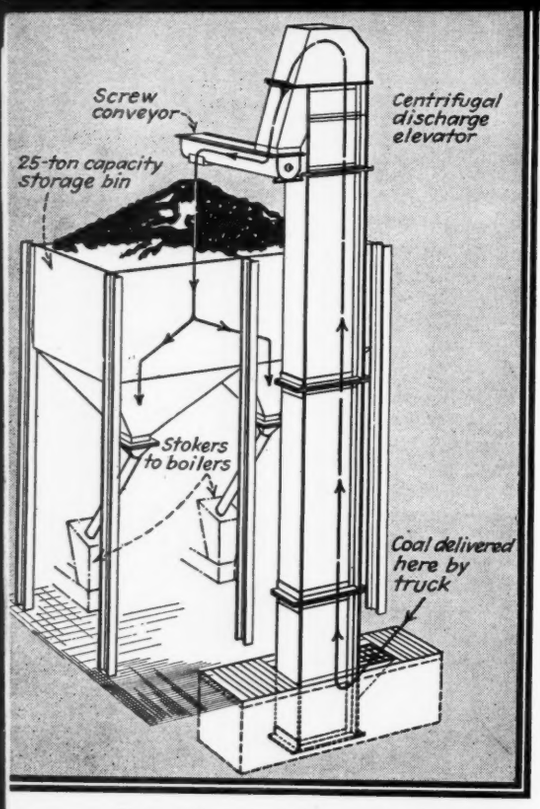


Fig. 1—How coal can be handled from truck to small-plant boiler furnaces by machinery

Good-Bye **Coal Shovel** in Small Power Plants

Here is the story of how modern equipment eliminates the drudgery of coal shoveling in small power plants, cuts operating costs, and improves employee-employer relations

By Wilbur G Hudson
ENGINEER, LINK-BELT CO

SMALL BOILER PLANTS using one or two carloads of coal weekly, with either hand- or stoker-fired boilers, have only recently been considered a fertile field for coal-handling and storage equipment. Two or three men from the labor gang took care of the unpleasant job of shoveling coal out of the cars, with a cost ranging from 25 to 50 cents per ton. Higher costs for fuel, and recent trends in labor relations, have made it desirable to offset increased operating costs while making labor more contented by eliminating unnecessary drudgery. Though the direct saving in dollars sometimes may not be impressively large, there are indirect factors which may be more important.

Automatic Weighing

Automatic weighing of coal, in combination with a steam-flow meter, provides a day-by-day check on performance and efficiency of major interest to the plant engineer. Clean conditions in the boiler room—good working conditions—make it possible to obtain and retain higher-class men. The writer has noted frequently the attitude of pride on the part of a fireman in a clean, well-equipped boiler room; the curious eagerness to show a visitor the workings of his automatic scales, his pushbutton controls, or a peep into the combustion chamber of his newly equipped boilers. He knows how much coal he is burning, and the pounds of steam developed per pound of coal. Throw a cigarette butt on the floor and you feel a chill in the warmth of the room. Contemplated improvements in methods of operation, in cleanliness or costs are welcomed with enthusiasm.

A simple equipment for transferring coal from cars to bin, consisting of a track hopper, elevator or conveyor, and a 3-hp motor, with a handling capacity of 25 tons per hr, usually costs less than $3,000 installed, including foundations. The time per car, as compared with shoveling, is reduced from a day or two to 3 hours, and the cost from around $15 to $5 or less, which covers 10% annual charge-off.

As automatic stokers are now standard equipment for small plants, stoker coal or small slack is readily handled by small-capacity conveyors, and the additional expenditure for an overhead bin with gravity feed to the stoker hoppers is well worth while. Fig. 1 shows such an installation. This plant receives coal by truck, using 5 tons per day in summer and 9 tons in winter. A 5-ton truck is cleared in 10 to 15 min. Overhead storage, though comparatively small, provides against interruption of delivery for a day or two. The fireman attends to the equipment in connection with his other duties. This installation, complete, including foundations, costs around $4,500.

Conveyor and Elevator

Fig. 2, inexpensive equipment for a small plant, has a screw conveyor in tandem with a short elevator serving two stoker hoppers. Should the attendant neglect to stop the conveyor when the hoppers are filled, the surplus spills out on the floor from the end of the screw. With truck delivery to a coal bin beneath the floor, the elevator boot on the right is placed for gravity flow from bin to boot. If the storage bin is above, the layout might be as in Fig. 3, coal coming into the screw conveyor at *A*. This is a rather neat arrangement, simple and clean in operation. Where the storage bin is outside and overhead, a neat screw conveyor may be installed as in Fig. 4. The cone-bottom tank feeds to a short section of 9-in. screw which is extended as a 12-in. screw spanning the stoker hoppers. Coal flow from the tank, limited to the capacity of the 9-in. screw, cannot stall or overload the 12-in. conveyor.

Since a check on coal consumed has both direct and indirect advantages, a weighing hopper should be provided when possible. Such a layout is illustrated in Fig. 5, a 2-stoker job. The weighing hopper is suspended from the roof structure. Coal is fed through either chute, but controlled by the gate at the junction. The scale dial is off to one side on the floor at *A*, out of the way of the fireman.

Coal-handling equipment is not essentially different where pulverized coal is burned, from where stokers are used. The pulverizers must have an uninterrupted supply of coal and provisions are desirable for elimination of rags, wood and tramp iron from the coal. Fig. 6 is a construction photo of a plant with two boilers, each with a unit pulverizer in the basement. The coal is handled from truck hopper to a suspended bunker by overlapping pivoted-bucket carrier, the vertical run of which is seen at the far wall. A larry is used in combination with an automatic scale. Controls are so arranged that a bunker gate cannot be opened until the larry is in position under that gate, and the larry may discharge only when it is over a pulverizer hopper.

Crushers

A crusher is not usually essential for the small plant. Coal in any desired size (slack or screened) is ordinarily available. If outside reserve storage may be subject to freezing, or if occasional bargains in run-of-mine coal are offered, a crusher is worth while, or at least provision made for its installation at a later date.

Generally speaking, it is not advisable to handle ashes in the coal elevator. Acid leached from quenched ashes rapidly corrodes steel plate. In larger plants, the overlapping pivoted-bucket carrier is an ideal conveyor for the combined duty, but in smaller plants some other inexpensive method of disposing of a few tons of ashes per week is usually advisable.

With somewhat larger coal consumption and delivery in carload lots, it becomes necessary to provide substantial storage capacity, either with an inside bunker or an outside silo. Fig. 7 shows a suspended bunker; a traveling weigh larry which makes the coal in any part of the bunker available for any boiler; and a skip hoist that discharges either to the bunker or to reserve ground storage. In this instance, the reserve storage is inactive and small in amount, and is reclaimed by a tunnel conveyor and a portable conveyor.

Silos, usually of 150 to 300 tons capacity, are quite frequently used for coal storage. They have a compartment in the upper section, from which

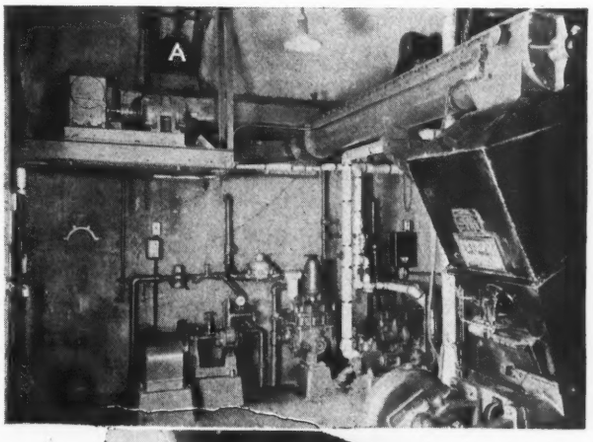


Fig. 3 — Two screw conveyors operating at right angles deliver coal from an elevated bin to the stoker

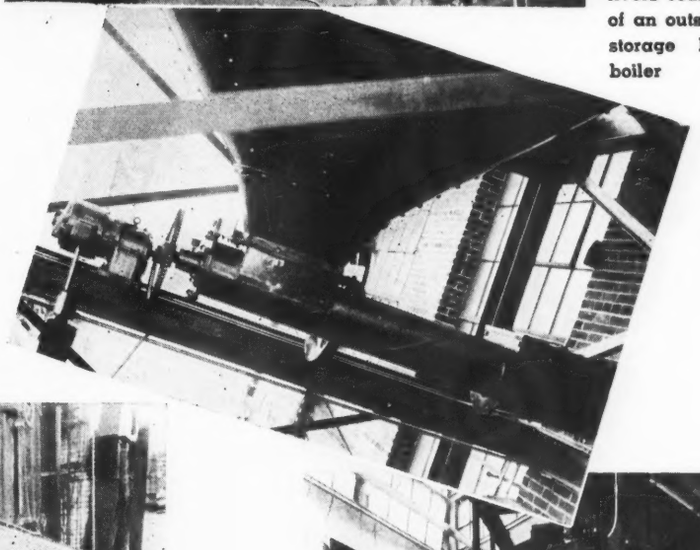


Fig. 4 — A short section of 9-in. screw, extended as a 12-in. screw conveyor over the stoker hoppers, delivers coal from bottom of an outside overhead storage bin to the boiler

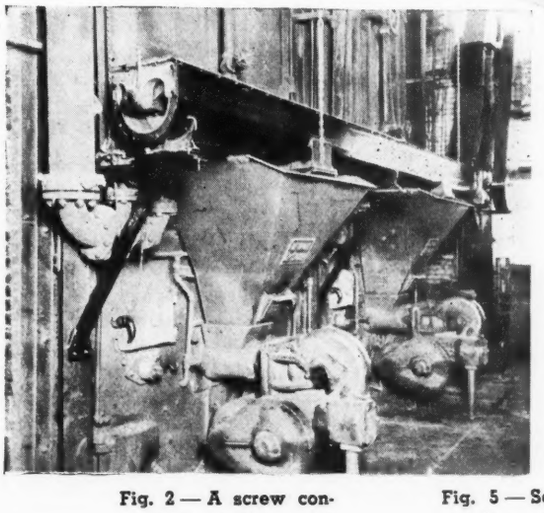


Fig. 2 — A screw conveyor in tandem with a coal elevator serves two stoker hoppers

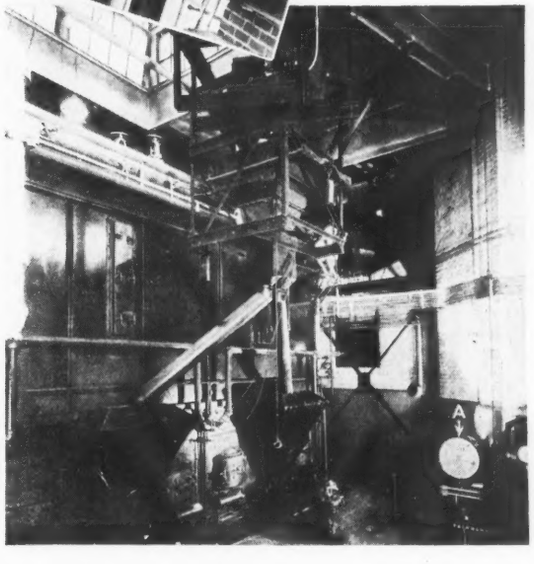


Fig. 5 — Scale hopper weighs coal from an overhead bunker to each of two stokers

the coal flows by gravity to the firing equipment or to a larry, and an overflow into the lower section. The latter serves as reserve storage and is rehandled to the upper compartment if needed. To reduce the rehandling expense, the live storage should be at least 50 tons. These monolithic concrete silos cost between $8 and $10 per ton of storage capacity.

If the coal supply is likely to be interrupted, or if coal in large lots can be purchased occasionally at favorable reduction in price, a reserve storage of several thousand tons may be desirable. This is usually spread out over the adjacent ground and reclaimed by a drag scraper. The unpleasant features are dust and freezing of wet coal. Quite recently, oil-sprayed coal at small premium has been made available. The dust nuisance is reduced and the liability of freezing is much less, as the oil sheds rain. It is possible that any tendency to spontaneous combustion is reduced if the coal is oil-sprayed. On the other hand, the oil ruins the rubber cover of conveyor belts. Belts faced with synthetic rubber, the manufacturers state, are able to resist this action. There is an interesting article in *Power*, July, 1937, by Ambrose and Gaspari, on oil-sprayed coal.

In the super-steam plant, dependability in the coal-handling equipment is vital. It may not be so important in the smaller plant, but it is essential that the installation perform without the annoyance of interruptions or high maintenance costs. The factor that tells the story is the cost per ton handled. Between good and poor installations, there is frequently but little difference in immediate maintenance costs, but the difference is emphasized after a few years.

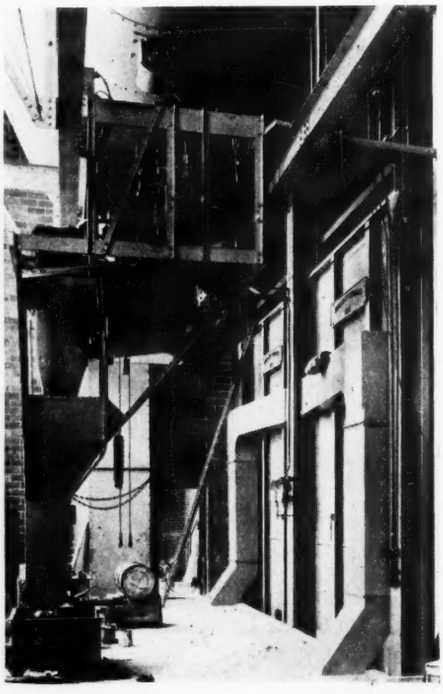


Fig. 6 — Larry in combination with an automatic scale delivers coal from bunker gates to unit pulverizers in a 2-boiler plant

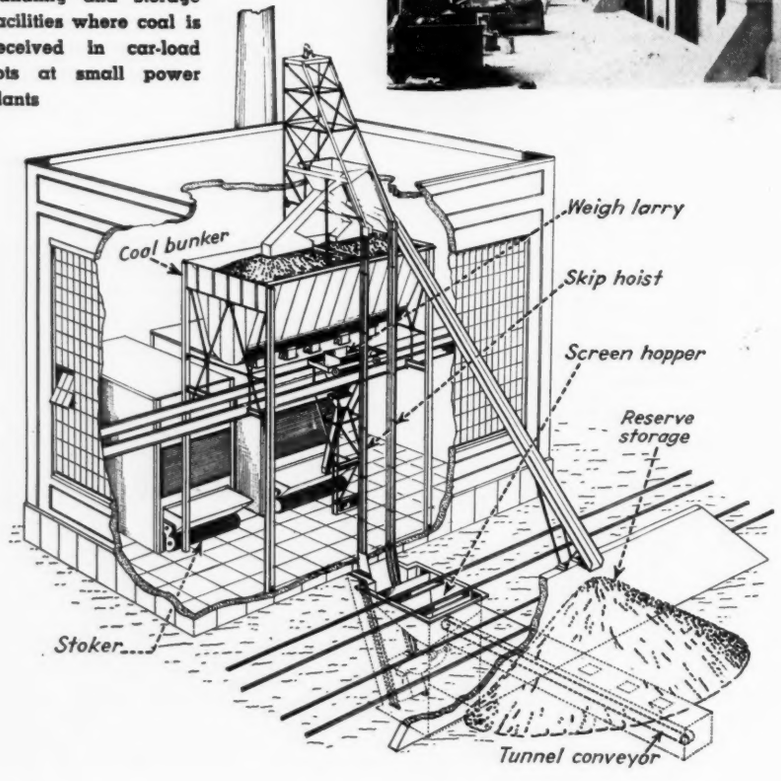


Fig. 7 — Typical coal-handling and storage facilities where coal is received in car-load lots at small power plants

Repair Costs Low

Surveys have shown remarkable results from high-class engineering. Repair costs as low as 0.03 cents per ton after 5 to 10 years' service are not unusual. In some cases, after 10 years the repair costs are still reported as negligible. Again, we have record of maintenance costs, where the type of equipment was ill-advised, running into several cents per ton handled. In one case, after 18 months' operation, with 12,000 tons handled, the replacement cost exceeded $800, or nearly 7 cents per ton. It is as true with coal-handling equipment as with other mechanical equipment, that one gets just about what he pays for. Good engineering will justify cost; but a cheap innovation should call for very careful investigation of performance and reliability.

Material-handling equipment today is the result of years of experience, gradual development and improvement. Anti-friction bearings, automatic releases, remote control, dust-proof operation, rugged details, and fool-proof design are recognized as worth extra cost. The first cost of one design may be 10 or 20% less than another, but if the installation ties itself up the first time wet coal or freezing weather is encountered, that 10 or 20% is soon absorbed in trying to keep equipment going.

$\frac{1}{4}$ of $\frac{1}{10}$ of $\frac{1}{1000}$

The limits on a diesel fuel injector are in the nature of one forty-thousandth of an inch, or as Charles F Kettering says it, "a quarter of a tenth of a thousandth of an inch." He visualizes it thus: Sawing a 3-ft log into 1-inch boards in a saw mill gives 36 1-inch boards, less the sawdust. Replace that log with a human hair and saw it not into 36, but into 120 "boards," then each will be about a quarter of a tenth of a thousandth thick. The funny thing about such accuracy is that the finished plungers do not wear and the fine holes through which the oil is forced do not wear out. Which indicates, says "Boss Ket," that there's a lot we don't know.

LUBRICATING SYSTEMS

Gunning With Grease

A thimbleful of grease at the friction point is worth a pound in the can. It takes pressure and tight joints to put grease on the spot. Here are guns and fittings to do the job

By James I Clower

ASSOCIATE PROFESSOR OF MACHINE DESIGN
VIRGINIA POLYTECHNIC INSTITUTE

PRESSURE application of grease may be simple, employing a hand-operated grease gun, or it may be relatively complex, involving the use of compressed air or an electric-, steam- or air-driven pump to force grease into the bearings.

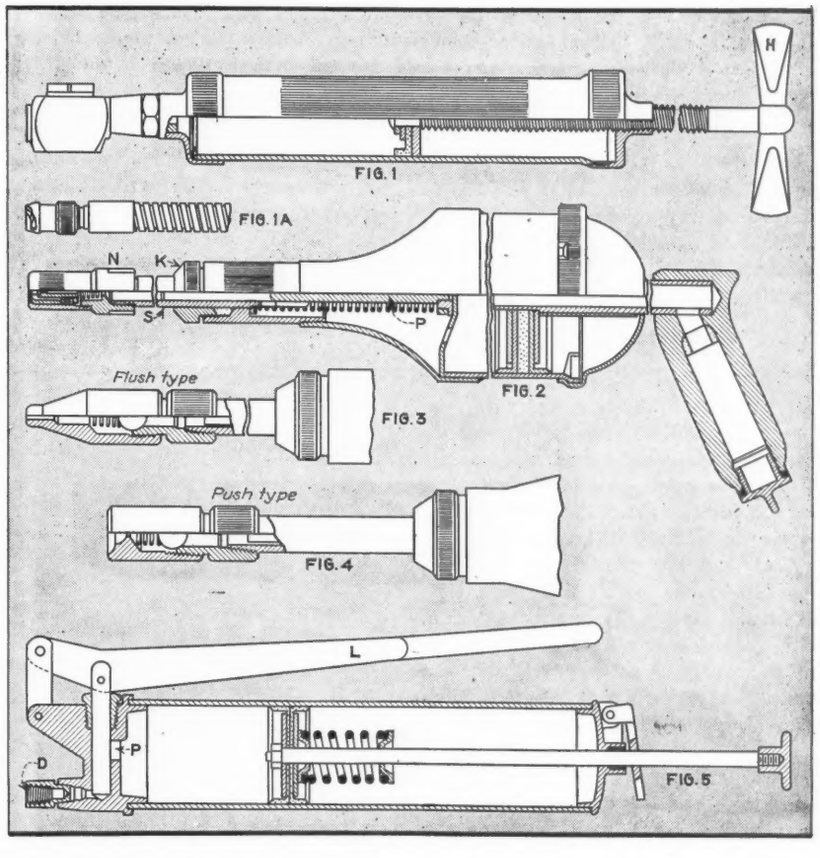
Figs. 1 to 5 show typical hand-operated grease guns. The simplest is the screw-plunger type, Fig. 1, operating on the same principle as the compression grease cup. By turning the handle *H*, the leather-packed plunger is moved toward the discharge end forcing grease out of the gun. Tee-handle *H* may be replaced by a wheel, or crank. At the discharge end, a ball check prevents flow of grease out of the gun after it is disconnected from the fitting. This type is made in 2-, 4-, 6-, 8-, 12- and 14-oz sizes, and is capable of producing a pressure up to 2,000 lb per sq in.

Hydraulic-Type Gun

When the hydraulic-type gun, Fig. 2, is pressed against the fitting, sleeve *S* slides back on plunger *P*, and forces a measured charge of grease into the bearing. When pressure is released, the spring returns the sleeve to its forward position. The discharge port is automatically closed by the ball check, and a fresh charge of grease is taken into the sleeve. Application of pressure to the pistol-grip handle forces grease in the cylinder towards the sleeve and nozzle at each application. This type of gun is capable of developing pressure up to 10,000 lb per sq in., and is available in 5-, 9-, 16- and 28-oz sizes. A gun similar to Fig. 2, made in 2-, 3- and 3½-oz sizes, is known as the vacuum type because grease is taken into the high-pressure chamber by atmospheric pressure. The quantity of grease delivered per stroke can be varied in this gun by placing collars of different lengths between the nozzle *N* and shank *K*, thus varying the length of stroke.

To apply grease under very high pressure as, for example, with heavy-bodied grades or when tight or clogged bearings are encountered, a so-called gat gun, Fig. 5, is used. When the hand lever *L* is raised, grease from the main chamber is forced into the high-pressure chamber through a port *P*. Pushing lever *L* down forces the grease through the discharge tube, connected at *D*, and into the bearing. A pressure as high as 10,000 lb per sq in. can be easily produced by this gun, which is made in 15- and 20-oz

Fig. 1—Screw-plunger grease gun equipped with double-duty button-head coupling. Fig. 1A—Bayonet-type coupling for screw-plunger grease gun. Fig. 2—Automatic hydraulic-type, 28-oz grease gun with filler-type handle. Fig. 3—Grease-gun coupling for flush-type fittings. Fig. 4—Grease-gun coupling for push-type fittings. Fig. 5—Gat-type 15-oz capacity grease gun for high-pressure applications



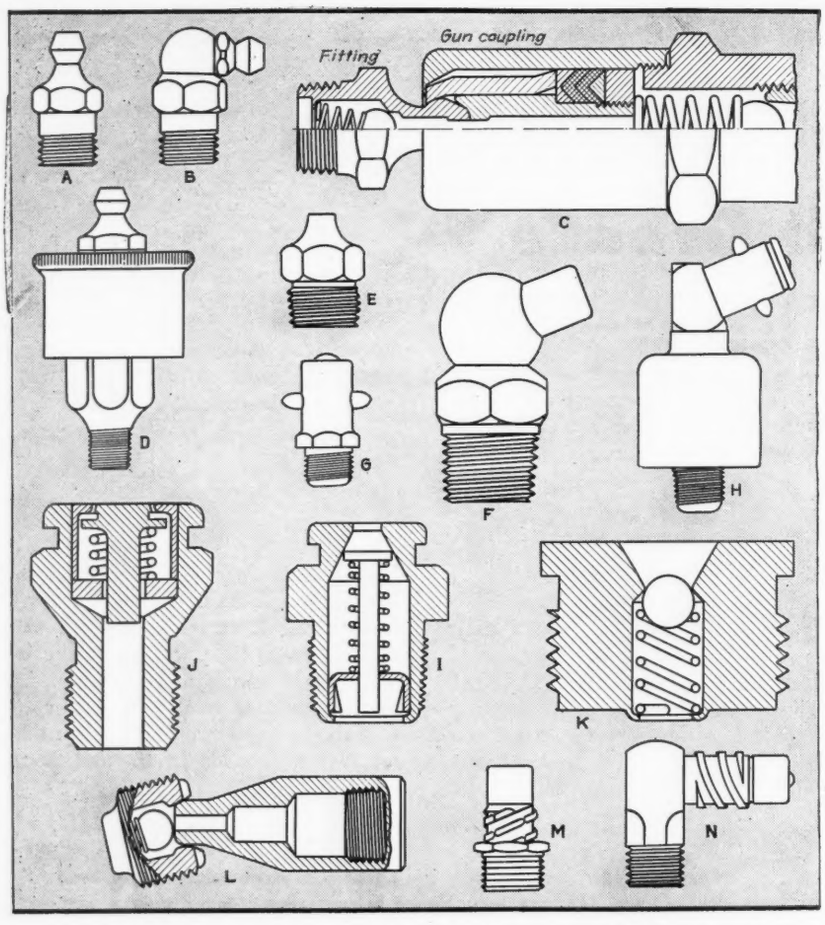


Fig. 6—Typical grease-gun fittings (many others are available). *A* and *B*, straight and 90-deg hydraulic fittings; *C*, cutaway view of hydraulic fitting and gun coupling, showing how the coupling grips the fitting; *D*, straight grease-cup fitting for filling from a gun; *E* and *F*, fittings for application of push-type grease gun; *G* and *H*, fittings for screw-plunger gun with bayonet-type coupling; *I* and *J*, button-head grease-gun fittings; *K*, flush fitting, used where space is limited; *L*, grease-gun nozzle applied to flush fitting; *M* and *N*, standard dot-type grease-gun fittings for heavy machinery

sizes. Another gat gun, known as the volume type, has a capacity of 16 oz, and delivers ¼ oz of grease per stroke. A third type has a pistol-grip handle and a capacity of 5½ oz.

Bearing Fitting

Where grease guns are used, it is necessary to equip bearings with special fittings of various types, such as shown in Fig. 6. *A* and *B* show one of the newer designs and the cut-away view *C* indicates how the gun coupling grips the fitting. These are so designed that the greater the pressure, the tighter the seal. With this type of fitting and a hydraulic-type gun, Fig. 2, pressures up to 10,000 lb per sq in. can be developed. *D* shows a hydraulic-type fitting applied to a grease cup for filling.

At *E* and *F* are two designs of push-type fittings. While in appearance this fitting is similar to the hydraulic type, the seal between gun fitting is quite different. Contact between the two is around the outer rim of the cone-shaped fitting. The seal has no tendency to become more secure with increased pressure, as is the case of the hydraulic-type fitting. With this fitting and a push-type gun, a maximum pressure of 6,000 lb per sq in. can be produced.

Figs. 6*G* and *H* are pin-type fittings with which is used a screw-plunger-type gun, fitted with either a rigid-bayonet coupling or a conduit hose, Fig. 1A. This fitting, designed with a crosspin, permits the bayonet coupling to be locked in place, and a maximum pressure of 2,000 lb per sq in. can be produced. For dusty conditions, this fitting may be equipped with dust caps.

Figs. 6*I* and *J* show button-head fittings, widely applied on heavy-duty machinery because of sturdiness. With this fitting it is necessary to provide a screw-plunger-gun with a different coupling from that used for the pin-type fitting. Three styles of coupling are made: pull-on, push-on, and hook-on, any one of which can be used with any of the screw-plunger guns.

Flush-type fittings for revolving or moving parts where a protruding fitting might be dangerous, are shown in Figs. 6*K* and *L*. They are also used on bearings where lack of space prohibits the use of protruding fittings. This design, as the name indicates, consists of a recessed fitting, which, when installed, sets flush or nearly so with the bearing surface. As shown, a ball check is provided in the fitting and the push-type gun makes contact around an internal, conical-shaped recess. A maximum pressure of 6,000 lb per sq in. can be produced. Two different sizes of guns are available: standard and giant, the latter being widely used on mine-car wheel bearings.

Dot-Type Fittings

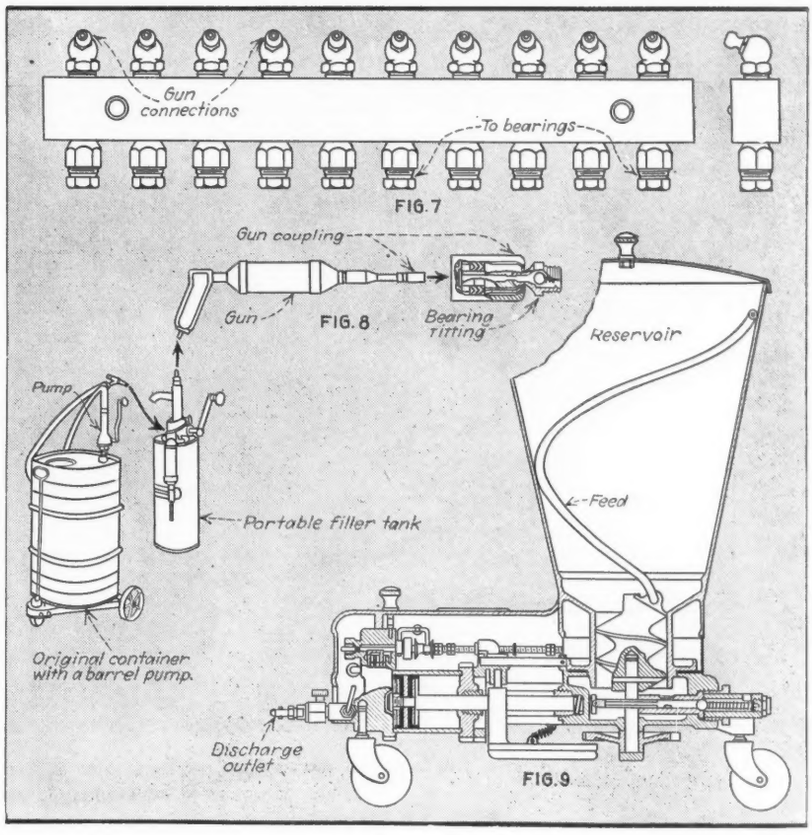
Dot-type fittings commonly used on heavy machinery, such as contractors' equipment, cranes, concrete mixers, bridges, etc, are shown in Figs. 6*M* and *N*. These fittings have a section of male Acme thread and the gun coupling has a corresponding female thread. A positive seal is made by placing the screw-type gun coupling over the fitting and giving it a quarter turn to the right. This securely clamps the gun coupling to the fitting and automatically opens the ball check. For regular service the fitting has a single-ball check. For use on air valves and water pumps, it has a double check. A maximum pressure of 3,000 lb per sq in. can be developed. These fittings are made in regular and mogul sizes and dust caps are available for both sizes where conditions warrant.

Fittings Available

All these different fittings are made in a large number of angles, shapes, sizes, only a few of which are shown. They are made with standard male and female pipe threads, as well as SAE machine and wood-screw threads. Rivet and drive types are also available, as well as drive bushings of various diameters for simplifying their installation in existing holes.

Fittings in Fig. 6 are extensively used on bearings relatively widely spaced. The lubrication of such bearings, however, can be centralized in a header, Fig. 7. The header is placed at any convenient place on or near the machine, and is connected by means of tubing to the bearings, thus making all bearings accessible. The machine may be lubricated in operation, dan-

Fig. 7—10-unit grease-gun manifold for centralizing greasing at a single location. Fig. 8—From barrel to bearing without exposing the grease to contamination. Fig. 9—Air-operated large-capacity gun, especially designed for handling heavy greases



ger to the oiler is minimized, and time required for lubricating is greatly reduced.

The grease-lubricating systems described flush the bearings of old grease and impurities on each application, reduce grease wastage, and prevent the ingress of dirt into the bearing through the oil hole which is securely sealed at all times by the ball check in the fitting.

Protection of Grease

As a further precaution to exclude impurities from bearings, equipment has been developed by which it is possible to transfer grease from the original barrel to the bearings without a possibility of contamination. This equipment comprises a special pump, which is inserted into the barrel through the bung, Fig. 8. A hose is attached to the barrel pump and provided with a fitting for easy connection to the portable filler tank, consisting of a 20-lb reservoir and a hand-operated pump. The portable filler tank is filled at the barrel and is carried by the oiler about the plant. A hand-operated pressure gun that can be filled through the handle is used. It is filled whenever necessary by removing a plug from the handle, Fig. 2, and placing the opening over the nozzle of the portable filler-tank pump. This system gives the oiler a substantial supply of grease to apply to the bearings with a light gun.

Where a large supply of grease is needed at all times, especially designed, high-pressure, volume guns, either hand or power operated, are employed. Such guns are connected to the bearings by a special rubber hose with suitable end connections. The volume gun, Fig. 9, is air operated and is especially designed for handling heavy greases. The special worm and helix arm inside the reservoir, operated by the air motor, forces the grease to the high-pressure piston. This gun develops a pressure 33 times the air pressure used, which varies from 125 to 150 lb per sq in. Gun capacity is 40 lb of grease. Other types of volume guns are electrically operated, capable of producing pressures up to 5,000 lb per sq in. at the control valve and have a capacity of 25 lb. Air and electric volume guns, similar in design to those shown, are available with various capacities and rates of delivery. Also, steam-operated volume guns can be had where neither air nor electricity are available.

Hand-operated guns are available with capacities of 5 to 28 lb of grease and for pressures up to 500 lb per sq in. They can deliver 0.3 to 1.2 oz of grease per stroke and are widely used in manufacturing plants, oil fields, tractor track rolls, mine-car wheels, covered springs and as loader pumps where air or electric power is not available.

Welding the lips of a Sarlun joint at Waterside station, New York, without removing the flange studs. Between making up the joint and the welding operation there elapsed several months, during part of which the steam line was operated at full temperature and pressure and the joint found tight without seal welding. The welding lips were first cleaned with a flexible file brush fastened on a canvas strip. To protect against accidental arcs, the heat-treated alloy-steel bolts were individually wrapped with asbestos.

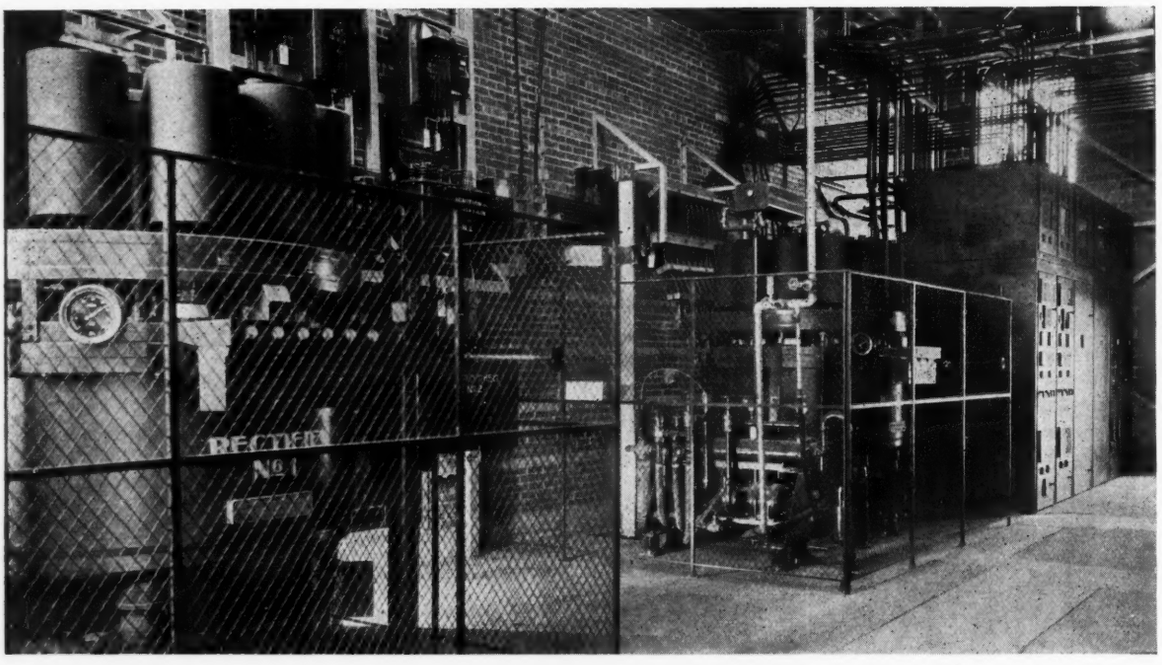


Fig. 1—Two grid-controlled mercury-arc rectifiers rated 2000 to 2800 kw. 500 to 1000 volts, supply dc power to an electrolytic process

New Fields for **Mercury-Arc Rectifiers**

Grid control opens many new industrial fields to mercury-arc rectifiers. Examples are railways, steel mills, radio stations, electrolytic plants, hoisting equipment

By Othmar K Marti
ALLIS-CHALMERS MFG CO

GRID-CONTROLLED mercury power rectifiers have many possibilities and advantages for a large variety of applications in the industrial field, in addition to the already established railway and electro-chemical services for which they have heretofore been employed.

The first power-rectifier installation with grid control to maintain constant voltage, independent of load or ac feeder voltage, supplies power to the Chicago surface and elevated traction lines and has given satisfactory service for several years. This unit, rated 625 volts, 3,125 kw, and with full-automatic control using a voltage regulator, maintains constant voltage from approximately no-load to half-load and provides a drooping characteristic above half-load. Since this first installation, several more units with a wider range of voltage control have gone into operation on the same systems.

Curves 1 and 3, Fig. 3, show how grid control can be used to flatten out the inherently drooping voltage characteristic of a rectifier by automatically lowering the voltage as the current is reduced. Curve 1 is the natural voltage characteristic of an uncontrolled rectifier, and curve 3 the flat voltage characteristic obtained by grid control. When necessary, grid control can give an overcompounded characteristic, just as readily as it can a flat-compounded regulation. It can also be set to take care of fluctuations in the supply voltage.

Curve 2, Fig. 3, gives the power factor corresponding to the unregulated voltage (Curve 1), while Curve 4 shows the slightly reduced power factor obtained when grid control

keeps the voltage characteristic flat as in Curve 3. Down to quarter load, the power factor is not lowered objectionably by grid control.

A recent steel-mill installation maintains a constant potential of 250 volts dc, regardless of supply-line voltage fluctuations or voltage drop due to load. Curve 5, Fig. 3, shows that the rectifier maintains a high efficiency down to low loads and therefore is particularly applicable for services having low load factors. This installation, in service for more than a year, has been found suitable for loads of this kind.

Radio Stations

To operate and protect equipment of a radio rectifier plant, it is important first to apply low voltage when starting the station, increasing the voltage automatically in small steps, and finally maintaining constant voltage in spite of any fluctuation that may occur in the ac supply-line voltage. It is also desirable to interrupt short circuits and flashovers in any part of the equipment as quickly as possible, and if the fault clears, start up again by gradually increasing the voltage to full value. This automatic restarting at reduced voltage can be done safely in such a short period that the service interruptions due to flashovers are scarcely noticeable in a broadcast program. Several such installations are in operation on this continent at voltages up to 15,000 volts dc and delivering up to 500 kw per tank.

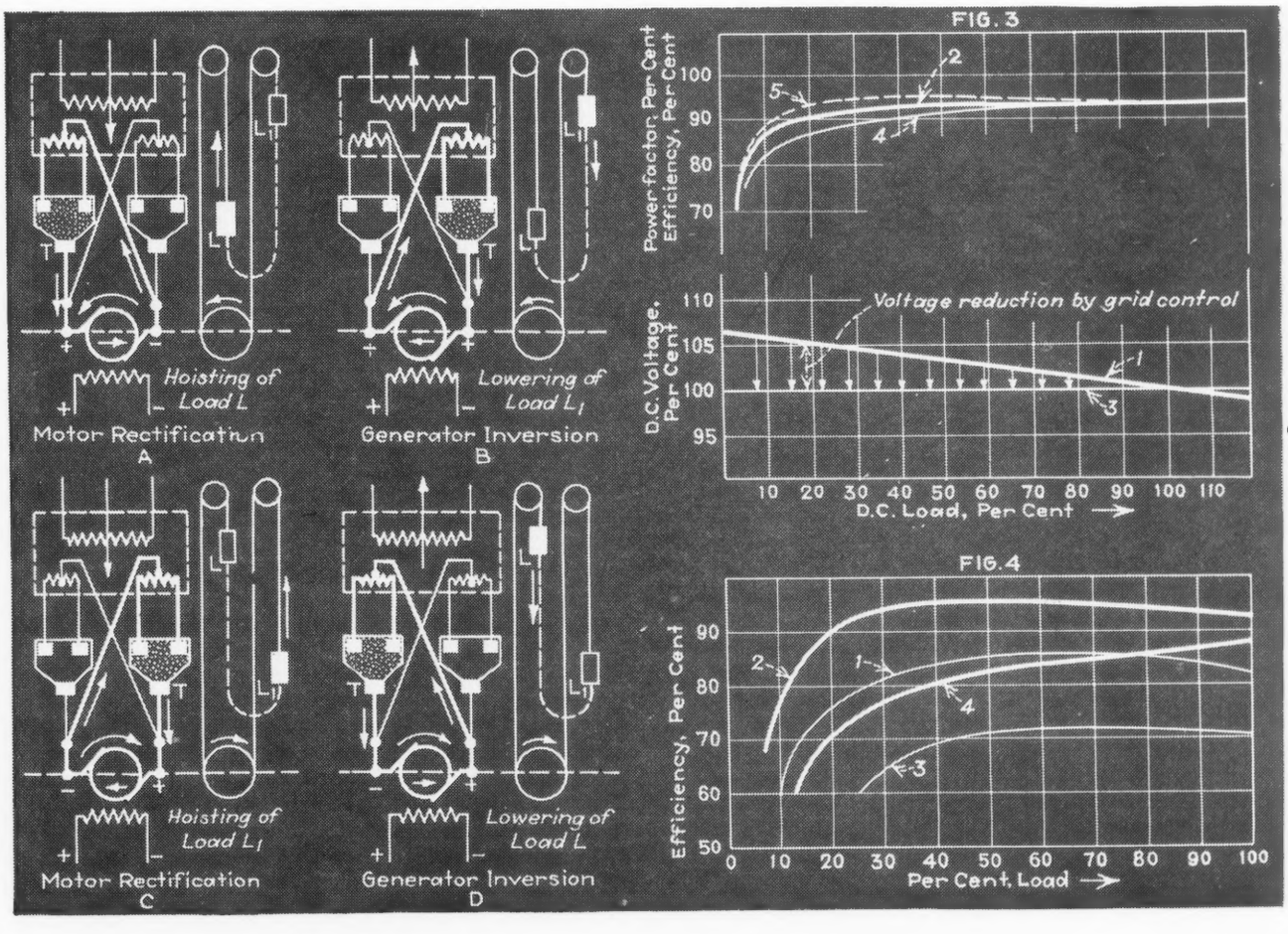
In electrolytic plants it is usually desirable to regulate the voltage from low to full value during starting, and to regulate the voltage during normal operation to maintain constant current. To do this, the regulator can be actuated by a current element and set to maintain constant current after the cell rooms are started. By disconnecting the regulator, the load can be reduced temporarily by manual means to meet any abnormal conditions, such as a shortage of power.

If a grid-controlled rectifier is operated continuously at reduced load, it may become uneconomical because of reduced power factor; and the increased ripple resulting from a large reduction in output voltage may be objectionable. In most applications, however, operation at greatly reduced voltages is not required, except for starting or temporary light loads, so that the reduced power factor is not objectionable and the circuit is usually such that its reactance smooths out the ripple considerably. If voltage has to be varied within wide limits at frequent intervals, high power factor and efficiency may be maintained by combining a few taps of large steps on the transformer with a fine regulation between taps by grid control.

Chlorine Cells

Several installations of grid-controlled rectifiers, with ratings as high as 4,500 kw at 600 volts dc, were completed during the last two years for furnishing dc power to chlorine cells. Part of a similar installation for 500 to 1,000 volts dc is shown

Fig. 2—Rectifier and invertor for speed control of reversing mill or hoist drive. Four operating conditions shown. Fig. 3—Voltage regulation, power factor and efficiency curves of grid-controlled mercury-arc rectifiers. Fig. 4—Efficiency of variable-speed drive, curves 1 and 2, with mercury-arc rectifiers. Curves 3 and 4 are with conventional variable-voltage converter



in Fig. 1. Three plants, having five 5,500-kw rectifiers supplying 45,800 amp for each plant at 600 volts, and equipped with unusual grid-control features, are being installed.

In spite of the fact that mercury-arc rectifiers at high dc voltages are more economical and more simple in installation and operation than high-voltage rotary coverters, their application to railway service was limited because regenerative braking was usually desirable. Development of grid control, which made possible reversing the direction of power flow (see *Power*, Nov. 1937, page 664), opened up this field of application to rectifiers. Several installations where regeneration of power is required are now in successful operation. Neither speed nor direction of rotation of the locomotive motors has to be changed. A simple resetting of the grid-control equipment and a reversal of polarity by switches between rectifier and motors effects regeneration during train descent. It is necessary only that the generated voltage be controlled when the motor works as a generator, which can easily be done by using suitable field control.

Hoisting Equipment

In reversing rolling-mill and hoisting machinery installations, the operating cycle includes starting, accelerating and decelerating, stopping, varying the speed, reversing direction of rotation, etc., requiring regenerative braking. For this type of service, the rectifier and inverter system previously mentioned are not suitable. A special connection was therefore developed for such applications, which includes one transformer, two mercury-arc valves, connected to a double transformer-secondary winding, and the necessary grid-control equipment.

The grid control is set so that during working of one arc tube as a rectifier, the other can operate as an inverter. Therefore, depending on network voltage, this static mercury-arc converter can either take power from the network or can feed power back into it automatically, without any change of connections.

The connections for the power circuit of such a system are shown in Fig. 2, which illustrates four different operating conditions. First consider them without referring to the indicated hoist equipment. During the first operating cycle, *A*, the motor can be made to accelerate by increasing the voltage of the rectifying tube *T*, so that the current stays below a predetermined value. In the next cycle, part *B*, the motor is braking by recuperation of energy. During this period the motor generates power as long as its induced voltage is greater than the counter dc voltage of the tube *T*. This tube, through its reversed connection, can permit current to pass through the motor in a direction opposite to that in cycle *A*, and therefore recuperation of electric energy into the network takes place.

Inverting-Tube Voltage

Inverting-tube voltage can be reduced by grid control as the induced voltage is lowered when the speed of the motor drops. Regenerated braking current can be kept within a predetermined value and the motor brought to standstill. If the firing time of the anodes of tube *T*, operating as an inverter, part *B* is shifted still further by grid-control, the voltage is reversed and the motor will run in the reverse direction by absorbing energy from the supply system, through rectifying tube *T* (diagrams *B* and *C*). That tube is now working as a rectifier, taking energy from the ac network. Increasing the rectifier voltage, by shifting the grid control, increases the motor speed until it attains normal operating value. During the next braking cycle, diagram *D*, the current is reversed and the motor works again as a generator and recuperates its stored energy, using tube *T* as an inverter. The motor will come to a standstill, this completing a full operating cycle.

Consider Fig. 2 once more, but in connection with the hoist arrangement directly connected to the motor. Diagrams *A* and *C* show the operating conditions during hoisting of the load *L* and L_1 and diagrams *B* and *D* show the operating condition when lowering the hoist or load. When the load *L*, diagram *A*, is being lifted, tube *T* is supplying power to the motor and the motor is rotating counterclockwise. During operating condition, diagram *C*, when load L_1 is being raised, tube *T* supplies power to the motor which then runs clockwise. When hoisting load *L*, diagram *A*, tube *T* is supplying the current. If braking is suddenly required due to improper manipulation of the control, then tube *T*, diagram *B*, can immediately come into action as an inverter. Energy flow is therefore reversed, and due to the special features of the connection, this can be accomplished immediately. It can be seen that the mercury tube with grid control, by permitting instantaneous operation and control, is well adapted to applications of this kind.

The principal advantage of a static mercury-tube equipment over the conventional variable-voltage converter, is indicated in Fig. 4. This shows the efficiencies in function of the load for both types of equipment using a 100-kw, 500-volt, and a 3,000-kw, 1,000-volt tube equipment.

It is therefore evident that the grid-controlled rectifier-inverter is destined to enjoy an ever-widening acceptance in diverse fields of industrial and general power applications.

No Plant is Safe from Fire

MODERN CONSTRUCTION has eliminated to a large extent the danger of serious fire loss in the power plant, but the possibility of damage and power interruption from fire still exists, according to an article in *Factory Mutual Record.*

Older plants are likely to have wooden roofs which should be protected by covering with asbestos or gypsum board, metal lath and cement plaster, or similar materials. Sprinklers can be safely used where plant voltage does not exceed 600, and where there are no large, expensive units. Non-combustible shields over generators and switchboards to prevent water damage make it possible to use sprinklers in plants operating at higher voltages.

Even in the modern plant, built on the "nothing to burn" idea, fires in generating and accessory equipment may cause serious damage. Oil-filled apparatus should be placed outdoors, or in special compartments, to segregate the fires that frequently follow electrical failures. Fires in enclosed generators are hard to fight from the outside; builtin carbon-dioxide systems or perforated water pipes over the end rings will overcome this trouble.

Insulation of grouped cable is likely to burn when a short occurs. New cable should have a non-combustible outer covering. Existing cable may be wrapped with asbestos tape saturated with silicate of soda.

Leaking oil piping and high-temperature-steam piping are a bad combination and should be widely separated if design will permit; if not, install sprinklers or spray nozzles over oil tanks, pumps, and lines, and provide hand hose lines.

For general fire fighting, hose streams and ample extinguishers are necessary. Carbon-dioxide and carbon-tetrachloride extinguishers are effective for small fires easily approached, and foam extinguishers are well suited for oil fires. Don't use water or foam on live apparatus.

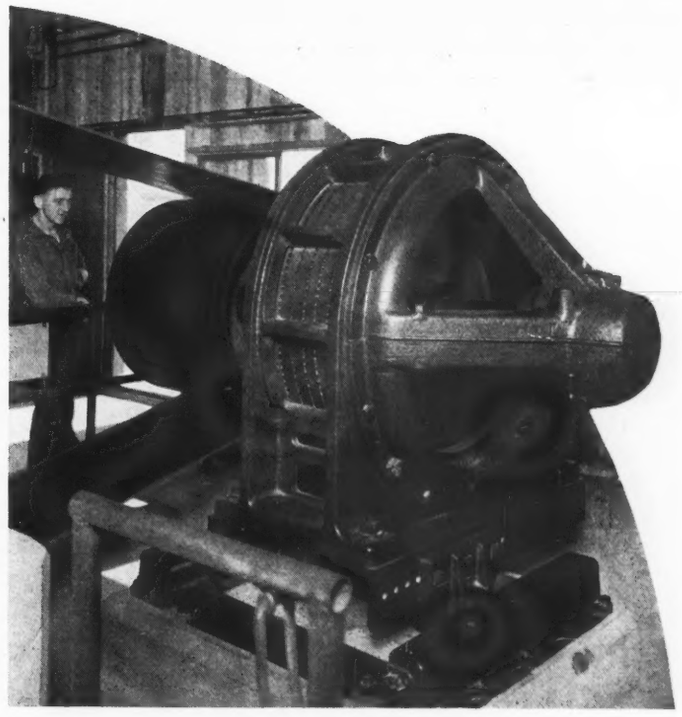


Fig. 1—A 200-hp, 600-rpm squirrel-cage induction motor mounted on a Rockwood base and driving an air compressor by a flat belt 24 in. wide and 30 ft 3 in. long

Size up Your MOTOR PULLEYS

What is the best size of motor pulleys? How big can they be? How small? Here are practical answers

By B S Weaver
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GENERAL ELECTRIC CO

THE ENGINEER selecting a motor pulley for a belt drive must keep within safe and workable dimensions. Within these limits he can select on the basis of convenience, first cost and efficiency. To help him choose pulley size intelligently, this article tabulates the accepted "standard" upper and lower dimension limits for various motor frames and speeds. It explains how these standard limits were determined, and presents the principles which must guide the engineer where circumstances force him to go above or below the established limits. The aim, in brief, is to show the reader how to keep out of trouble in selecting motor pulleys for flat-belt drives.

Present motor designs in standardized dimensions are available for a large number of horsepower and speed ratings for each frame size. If torque were constant it would be possible to select, for use on a given frame, a pulley size that approached minimum recommended diameter for safe belting practice.

While a given motor frame may have a definite torque rating, there are modifications such as speed and temperature which are taken into account in establishing horsepower and consequently torque rating. For this reason, pulley sizes standardized by the National Electrical Manufacturers Association for motors of standardized dimensions are a compromise. In the same manner, standard pulley sizes have been established by motor manufacturers for other motor frames which do not conform to standardized dimensions. The need for smaller pulleys is recognized and limiting values are usually listed by the manufacturer for each horsepower and speed rating available in any frame.

Bearing loads depend upon spacing between bearings, weight supported, amount of the belt load and its location with respect to the bearings. Shaft loads must also be considered from the standpoint of combined torsion and bending caused by the power transmitted and unequally distributed weights and bending loads. General Electric practice allows a liberal factor of safety over shaft stresses calculated on overloads which may reasonably be expected in motor applications. The practice in bearing design is to maintain conservative bearing temperatures, inasmuch as the temperature depends upon rubbing speeds as well as bearing loads. Where rubbing speed is high, unit pressure must be reduced to prevent excessive heating. The unit pressure is the total load on a bearing divided by its projected area.

Bearing loads as determined by belting formula take into account the total pull by the tight and slack sides of the belt and a safe value for the coefficient of friction. Motor belt drives are usually figured on the assumption that tight-side tension is 3 times slack-side tension.

This approximation has proved satisfactory for many years. On this basis, the total pull on the pulley is double the "load pull" ("load pull" is difference between tensions on tight and slack sides). This two-to-one ratio has proved adequate and is rarely exceeded when applying and operating belts by experienced help, even though the belts may be tightened at rest by moving the motor away from the drive.

NEMA Standards

Table I gives dimensions of standard and minimum pulleys recommended by NEMA. The table also gives maximum allowable belt width for each motor rating. Pulley diameter must have an upper limit to keep peripheral speed and belt speed within safe limits (usually not over 5,000 fpm). Table II shows pulley diameters corresponding to 5000 fpm at various motor speeds.

Belts and pulley are sometimes operated considerably above 5,000 fpm, but it is advisable to consult the belt and pulley manufacturers for their recommendations before doing this. A belt speed of 4,000 to 4,500

Table II—Max. Pulley Diam. for Belt Speed Not to Exceed 5000 FPM

Full-Load Motor Speed, RPM.....	3,450	1,750	1,450	1,150	960	860
Max. Safe Pulley Diameter, In.....	5½	11	13	16½	20	22
Full-Load Motor Speed, RPM.....	850	720	690	575	475	....
Max. Safe Pulley Diameter, In.....	22½	26½	27½	33	40	....

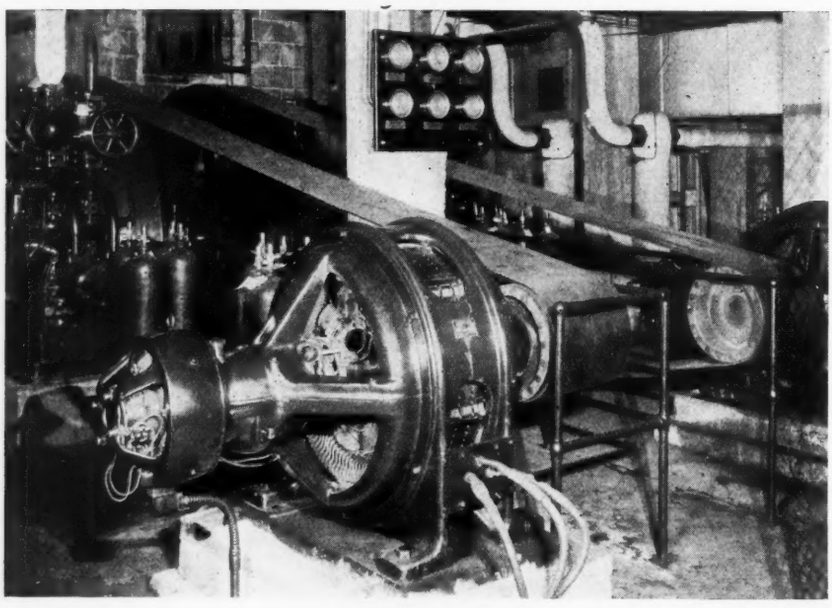


Fig. 2—Two 150-hp, 720-rpm synchronous motors belted to a single-cyl double-acting CO_2 compressor

fpm is a more conservative value, and the standard pulley diameters given in the table falls below these values in most cases.

Where large speed ratios are required, it is desirable to make the motor pulley as small as possible, so that the driven pulley will not be inconveniently large. Frequently, the driven pulley diameter will be limited by available space so that the desired speed ratio can be obtained only by reducing the diameter of the motor pulley. Reducing the pulley diameter decreases the belt speed and the amount of power that it can transmit per inch of width, so that a wider belt and pulley are needed to transmit a given horsepower.

But there are practical limitations to belt width. An extremely wide belt moves the center of load application outward from midpoint of the shaft extension (the point generally used in determining bearing loads), thereby

Table I—Standard and Minimum Pulley Sizes Recommended by NEMA for Motors of Different Capacities and Speeds

	Synchronous Speed and Motor Horsepower											Standard Pulley			Minimum Pulley		
Frame No.	3,600 Rpm	1,800 Rpm	1,500 Rpm	1,200 Rpm	900 Rpm	750 Rpm	720 Rpm	600 Rpm	500 Rpm	514 Rpm	450 Rpm	Dia. In.	Width In.	Belt Width	Dia. In.	Width In.	Belt Width
204.....	1–1½	1	¾	¾–1	½	½	....	....	....	....	....	3	3	2½	2½	3	2½
224.....	2–3	1½	1	1½	¾	¾	½	....	½	....	....	4	3½	3	2½	4½	4
225.....	....	2	....	....	1	1	¾	½	....	....	....	4	3½	3	2½	4½	4
225.....	5	3	1½	2	....	1	¾	½	¾	....	....	4	3½	3	3	4½	4
254.....	....	....	....	....	1½	1½	1	¾	....	....	....	4½	4½	4	3	4½	4
254.....	7½	5	3	3	2	2	1½	1	1	....	....	4½	4½	4	3½	4½	4
284.....	10	7½	5	5	3	3	2	1½	1½–2	¾–1	¾	5	4½	4	4	5½	5
324.....	15	....	....	....	....	....	....	....	....	....	....	5	6¾	6	5	6¾	6
324.....	....	10	....	7½	5	5	3	2	....	1½	1	6	5½	5	5	6¾	6
326.....	20	....	....	....	....	....	....	....	....	....	....	5	6¾	6	5	6¾	6
326.....	....	15	7½	10	7½	7½	5	3	3	2	1½	8	6¾	6	6	7¾	7
364.....	....	20	10	....	....	....	....	....	....	....	....	9	7¾	7	7	9¾	9
365.....	....	....	15	15	10	10	....	....	....	....	....	9	7¾	7	6	9¾	9
365.....	....	25	....	....	....	....	7½	5	5	3	2	9	7¾	7	8	9¾	9
404.....	....	....	20	20	15	....	10	7½	7½	5	3	10	7¾	7	8	11	10
405.....	....	30	....	....	....	....	....	....	....	....	....	10	7¾	7	9	11	10
405.....	....	....	25	25	20	15	15	10	10	7½	5	10	7¾	7	8	11	10
444.....	....	40	....	....	....	....	....	....	....	....	....	11	9¾	9	9	13	12
444.....	....	....	....	30	25	20	20	15	....	10	7½	11	9¾	9	8	13	12
445.....	....	....	30	40	30	25	25	20	15	15	10	11	9¾	9	10	13	12
504.....	....	....	40	50	40	30	30	25	20	20	15	12	11	10	10	15	14
505.....	....	....	....	60	....	....	....	....	....	....	....	14	13	12	12	17	16
505.....	....	....	....	....	50	40	40	30	25	25	20	14	13	12	11	17	16

increasing these loads. An unusually wide belt might cause overloading of the bearing.

In Table I, the belt widths for *minimum* pulleys are the standard *maximums* recommended. Before using wider belts than these, the motor manufacturer should be consulted. Even the tabulated maximum allowable belt width may bring the belt center beyond the midpoint of the shaft extension in some cases. This location, however, has been considered in determining the allowable minimum pulley diameter.

The belt width for the different motor ratings will, in general, be found quite liberal. For example, Frame No. 364 has 20-hp rating at 1,800 rpm. At full load this motor will operate at about 1,750 rpm. Its standard pulley is 9 in. in diameter and its minimum pulley 7. At 1,750 rpm, the former will give a belt speed of 4,100 fpm and the latter 3,200 fpm. At these speeds, belts of the widths recommended can be readily obtained to transmit 40 hp or double the motor rating, which is the belt capacity usually recommended when squirrel-cage induction motors are started on full voltage.

Minimum pulley dimensions given in the table are those that will permit connecting the motor to its load with a belt having a reasonable reserve capacity to take care of starting conditions, peak loads and other factors encountered in practice. The diameter of the pulley is not, however, the minimum over which the belt can be safely operated because of internal bending stresses. On a basis of these conditions, minimum pulley diameter will vary according to grade and kind of belt, but in all cases it will be found well below the minimum diameter given in Table I.

Table III—Recommended Maximum Ratings of Two-Bearing Motors for Flat-Belt Drives

Motor speed (syn.)..	1,800	1,500	1,200
Motor horsepower ...	40	40	75
Motor speed (syn.)..	900	720	600
Motor horsepower ...	125	150	200

Min. Pulley Dimensions

For example, Frame No. 364 specifies a minimum pulley diameter of 7 in. One belt manufacturer specifies a minimum pulley diameter of 4.5 in. for a belt that would be used on such an application at 4,000 fpm. This pulley is 2.5 in. smaller than the pulley diameter tabulated for Frame No. 364 when operating under maximum conditions of 20 hp. at 1,800 rpm. The reason for the difference is obvious: Pulley sizes in the table are based on motor bearing considerations, whereas minimum pulley diameters specified by belt manufacturers are based on belt characteristics. Of course, motor considerations should govern in this case, but, fortunately, what is good for motor is also good for the belt. In some frame sizes, motor manufacturers may permit smaller pulleys than the standard minimum, but it is advisable to consult them before using smaller pulleys than recommended.

Problems involving speed ratios, center distances, load factors and ambient conditions of temperature, dirt, fumes and moisture should be referred to the mechanical-power transmission manufacturer for analysis.

Certain forms of belt-tightening bases use the weight of the motor, mounted on a rocker arm, to maintain belt tension. One of these drives is shown in Fig. 1. They may also be used with multiple V-belt drives. With the tension thus maintained under running conditions, larger pulley ratios and closer shaft center distances than those recommended in standard belting practice are allowed. Motor torque aids motor weight in keeping the belt tight when the tight side of the belt is underneath and opposes when the slack side is down. It is obvious that attention must be given to correct installation in order to obtain the full benefit of the drive and to prevent overload on the motor bearings.

In Table I, motor sizes are based on 2-bearing constructions for belt drive, but at the slower speeds, considerably larger ratings are permited by many motor manufacturers. Motor ratings given in Table III represent good belting practice. These ratings are based on the use of pulleys standardized by the National Electrical Manufacturers Association. Where it is desired to use belt drives on motors of ratings above those given in Table III, the outboard bearing construction, is recommended. For flat-belt, multiple V-belt and chain drives, the assembly includes outboard pedestal base and belt-tightening rails.

Oil For Business Friction

ARBITRATION is the oil that will prevent friction in business relations. Just as good lubrication saves time and money in the plant, use of arbitration will save time and money in settling disputes with contractors, suppliers, or customers. What then is arbitration and how can it be applied to everyday affairs?

Most business dealings are covered by contracts, which tell what each party to the deal is supposed to do and what each is to get for it. No matter how well drawn a contract is, a dispute is likely to arise over its terms. Even more trouble is likely to result from relations not covered by contracts. Going to court has been the time-honored means of settlement, with all the attendant delay, expense, and publicity. Arbitration is offered as a streamlined substitute.

Briefly the idea is this: Arbitrators are selected by both parties from a list of men designated as qualified. Such lists are furnished by the American Arbitration Association, a nonprofit organization of arbitration-minded businessmen. The arbitrators hear the case, and make a decision which has the force of law, since arbitration procedure is supported by federal and state laws. Note that it is not a compulsory compromise, but a verdict on the merits. Red tape and publicity are absent, costs low.

How can you get these benefits? Make a habit of insisting on an arbitration clause in contracts. Be sure it refers to the rules of an established arbitration tribunal, as this insures proper handling if trouble occurs, and protects the award from attack on the grounds that the proceedings were not conducted according to prevailing arbitration law. The American Arbitration Association recommends the following clause:

"Any controversy or claim arising out of or relating to this contract or the breach thereof, shall be settled by arbitration, in accordance with the rules, then obtaining, of the American Arbitration Association, and judgment upon the award rendered may be entered in the highest court of the forum, state or federal, having jurisdiction".

If no contract is drawn or a dispute arises on a contract not including an arbitration clause, arbitration may be had on consent of both parties.

Specific information about procedure or theory can be readily answered by the American Arbitration Association, 8 West 40th St, N. Y. C.

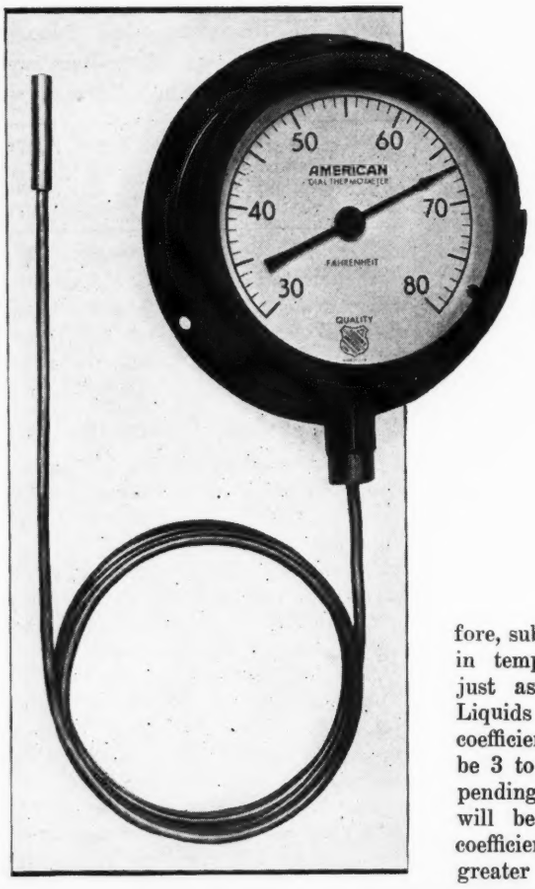


Fig. 1—Liquid-actuated dial thermometer with short capillary. Note uniform scale and small bulb

Liquid-Filled Dial Thermometers

The last of five articles describes the liquid-filled instrument, gives specification data and compares the four types of dial thermometers

By E H Hammond

CHIEF ENGINEER, AM. S & B INSTRUMENT DIV, MANNING, MAXWELL & MOORE, INC

LIQUID-FILLED distant-reading dial thermometers are similar to the mercury-filled instrument, described in *Power*, September, 1937. The system, consisting of bulb, capillary, and bourdon spring is highly evacuated, and filled solid with a liquid under initial pressure. In theory and operation, it differs from the mercury-filled type only in characteristics of the filling liquids, which usually are hydrocarbons such as kerosene, ether, alcohol, or xylene. As the liquid in the bulb is heated or cooled, the bourdon spring expands or contracts with change in volume. Linear motion produced at the bourdon tip is translated into rotary motion of the pointer through the conventional sector and pinion movement.

Liquids used as fillings are non-corrosive, and will not amalgamate with non-ferrous metals, which mercury does. Therefore, the system can be made from copper and bronze, with soldered connections, and is less expensive to manufacture than the welded all-steel mercury-filled system. Also, the liquid fillings themselves require less skill and precaution in factory handling, and this tends further to reduce the cost. However, any price advantage must be balanced against certain disadvantages which narrow the field of usefulness.

The system is solid filled, and, therefore, subject to line error from changes in temperature along the capillary, just as is the mercury-filled type. Liquids used as fillings have high coefficients of expansion, which may be 3 to 8 times that of mercury, depending on the liquid used. Line error will be nearly proportional to the coefficient of expansion, therefore much greater with liquid-filling than with mercury filling. Otherwise, factors influencing or determining line error will be quantitatively the same for these liquids as for mercury.

An important point in connection with liquid-filling is that line-error compensation must be applied, except under the most favorable conditions of installation. This alone may more than offset any advantage of lower manufacturing cost where liquid-filled thermometers would require compensation for line error and mercury-filled would not.

In most commercial liquid-filled thermometers, the system pressure is limited by bourdon-spring design and material to a value considerably lower than is considered good practice with mercury. Liquid fillings all have a much higher factor of compressibility than mercury. For example, ether will be compressed approximately 33 times more than mercury under a pressure of 150 lb, and alcohol approximately 22 times. Higher compressibility tends to increase the necessary bulb size, which is another reason for keeping system pressure lower.

Power

Power available for operating a solid-filled system depends on filling, compressibility and coefficient of expansion. Negretti & Zambra in "Mercury in Steel Thermometers," show that under specified conditions, a mercury-filled thermometer will have ap-

proximately 4 times the power of one filled with ether.

As outlined in previous articles, lag of a thermometer will depend among other things on the thermal characteristics of the filling, and on the size and shape of the bulb. By virtue of the higher expansion coefficient of its filling, a liquid-filled-thermometer bulb will be much smaller than a mercury-filled one for the same range, although reduction in bulb size will be modified by the higher compressibility of the liquid. The smaller bulb helps to reduce lag, but since the heat conductivity of mercury is 40 to 50 times greater than for the liquid fillings, the over-all inherent sensitivity of the mercury-filled type will be greater. That is, a mercury-filled thermometer will respond more quickly to a change in temperature than will a liquid-filled system.

The filling for a thermometer must be pure and free of all matter which might freeze, plug the capillary, or break down under high heat. Thermometer manufacturers usually must depend on outside sources for purity control in liquids purchased for fillings. With mercury it is easier for them to set up their own distillation equipment, and thus maintain control over purity of mercury used for filling. It is good practice to use a fine-bore capillary with a liquid-filled system for the same reason advanced for mercury, to reduce line error. Anyone who has attempted to confine mercury knows how hard it is to hold. This property makes it possible to use finer bore capillaries with mercury than with other liquid fillings without danger of plugging the system.

Bulb-Elevation Error

As with mercury, there can be no bulb-elevation error until the hydrostatic pressure exceeds the internal-system pressure. The initial pressure usually will be several hundred pounds per sq in. with any of the liquid fillings. For commercial installations, no correction for elevation will be required.

It is possible to select fillings for liquid-filled thermometers that have a much lower freezing point than mercury. These permit the liquid-filled types to be used for temperatures below —40 F, but their upper range is about 750 F compared to 1,000 for mercury-filled dial thermometers.

Liquid-filled and mercury-filled thermometers belong to the same family, and the differences will be more in degree than in characteristics. Therefore, there is no need of repeating the general discussion which appeared in the article on mercury-actuated dial thermometers.

Perhaps something should be said regarding the scope of the two types. Mercury-actuated dial thermometers are used throughout industry wherever a powerful, accurate, rugged dial thermometer is required. There will be installations where a liquid-filled thermometer must be used to meet special operating conditions. In general, however, liquid-filled thermometers are best suited for handling on a production basis for services where a standardized, cheap, powerful system is required, and where the line lengths and temperature changes are such that simple case compensation will give sufficient accuracy. It is limited as to flexibility, scope, and range, and should not be used if mercury, vapor-pressure or gas-actuation would be better suited for the service.

A 12-point comparison of the four types of dial thermometers follows:

Mercury-Filled Types

1. Solidly-filled with mercury under high initial pressure. Deflection of bourdon spring measures direct expansion and contraction of mercury as bulb is heated or cooled.
2. Most expensive to build. Entire system all-steel welded construction.
3. Does not require correction for bulb elevation.
4. Not affected by reversal of bulb and line temperatures.
5. Compensation required for error of long lines or for large changes in line temperature. Compensation may be either partial or full, as required.
6. Working range between minus 40 and plus 1000 F. Range can be as short as 30 and as long as 1040 F.
7. Scale graduations uniform. Accuracy high over whole scale.
8. Bulb relatively small, especially for long ranges. Bulb volume varies inversely with length of range.
9. Bulb can be made quite long to obtain average temperature. Is true averaging type.
10. Has good heat sensitivity, influenced by size and proportions of bulb.
11. Most powerful and rugged of all types.

SPECIFICATION DATA

Orders or inquiries covering dial thermometers should include as much of the following information as possible:

1 — Type preferred: mercury, liquid, vapor pressure, gas.

2 — Working range: Give maximum, minimum, and working temperatures.

3 — Temperature scale: Fahrenheit or Centigrade.

4 — Line length: After fabrication, the length cannot be increased except by complete rebuilding.

5 — Size of dial preferred.

6 — Type of bulb required: plain, union-connected, separable-socket, extra sensitive, averaging, etc.

7 — Nature of fluid in which bulb or socket will be immersed; if the fluid is corrosive give material from which container is made, with alternate recommendations for other suitable materials. Will the line armor be subjected to corrosion? If so, of what nature.

8 — Size of bulb: Give minimum and maximum size that can be installed.

9 — Line temperature: Give maximum, minimum and normal temperatures to which the line and spring will be subjected.

ADDITIONAL DATA FOR VAPOR-PRESSURE

10 — Bulb elevation: Give distance, and whether above or below instrument.

11 — Temperature reversals: (a) Will the bulb always be hotter than the line and spring? (b) always colder than the line and spring? (c) sometimes hotter, sometimes colder than the line and spring?

12 — BULB ELEVATION MUST BE GIVEN; ALSO VARIATIONS IN LINE TEMPERATURES.

Fig. 2—Specification data that should be given the manufacturer when ordering dial thermometers

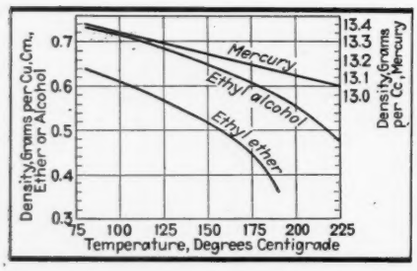


Fig. 3—Density-temperature curves for mercury, ethyl alcohol and ethyl ether. Rate of density change is proportional to expansion, which for mercury is constant, but changes rapidly for the liquid fillings

12. Will not stand appreciable over temperature, unless specially protected.

Vapor-Pressure Types

1. System partially filled with volatile liquid. Bourdon spring deflected by vapor pressure of liquid in bulb.
2. May be fabricated entirely of nonferrous materials.
3. Will not have appreciable line error unless bulb has considerable elevation above or below instrument case, when a pointer correction must be made for hydrostatic head. Should never be installed with bulb elevated if range is such that bulb and line temperatures may cross or reverse each other, unless system is especially compensated.
4. Erratic pointer fluctuations if bulb and line temperatures reverse, unless system is specially compensated.
5. See 4.
6. Large selection of ranges, including temperatures as low as minus 40 and as high as 650 F, but not in one range.
7. Scale not uniform. Divisions increase progressively through range. Accuracy poor in lower portion of range.
8. Bulb can be made small if it is always hotter than line and case, otherwise bulb must be large enough to take all liquid from line and spring.
9. Will not indicate true average or hottest temperature of bulb. Bulb should be kept short as possible.
10. Has good heat sensitivity. Suitable for indicating rapidly changing or fluctuating temperature.
11. Inherently sturdy and accurate, provided filling-liquid and bourdon-spring characteristics are properly matched.
12. Must be protected against even moderate over-temperature.

Gas-Filled Types

1. Filled with an inert gas under initial pressure. Bourdon spring deflected by changes in pressure as gas in bulb is heated or cooled. Absolute pressure in system nearly proportional to absolute temperature.
2. Can be fabricated entirely of nonferrous materials.
3. Does not require correction for bulb elevation.
4. Not affected by bulb and line temperature reversals.
5. Does not normally require line error compensation other than bulb, which must be large to reduce line error. Large bulb may be difficult to install.
6. Working ranges between minus 60 or less and plus 1000 F. Range can be as short as 150 and as long as 1000 F.
7. Scale graduations uniform, accuracy high over whole range.
8. Bulb can be made quite long, but minimum length is limited.
9. Is not true averaging type, but will indicate approximate average temperature if temperature differences along bulb are not too great.
10. Large bulb and poor heat conductivity of gas reduces heat sensitivity.
11. Less rugged than other types.
12. Will not stand appreciable over-temperature.

Liquid-Filled Types

1. Solid filled with a non-corrosive liquid under moderately high initial pressure. Bourdon-spring deflection measures direct expansion and contraction of liquid as bulb is heated or cooled.
2. Less expensive to manufacture than mercury-filled when compensation is not required. Can be made of copper, brass or bronze with soldered connections.
3. No error due to bulb elevation.
4. Not affected by reversal of bulb and line temperatures.
5. Has much greater line error than mercury-filled type. Line error compensation required except under most favorable conditions.
6. Working range between minus 40 or less to about plus 750 F. Range may be as short as 30 F.
7. Scale graduations uniform over the shorter ranges; not uniform for ranges much longer than 300 F.
8. Bulb inherently small, volume varies nearly inversely to length of range.
9. Is of true averaging type, but because of small volume, difficult to build bulb sufficiently long for averaging.
10. Small bulb gives high heat sensitivity.
11. Stands next to mercury-filled type for ruggedness. Has approximately 25% power of mercury-filled type for given change in temperature.
12. Will not stand appreciable over temperature.

PF Correction
Downs Power Costs

A 2000-kva synchronous condenser corrects power factor in an industrial plant, improves voltage regulation and pays its installation cost in a short time

By Gordon Fox
VICE-PRESIDENT
FREYN ENGINEERING CO

POWER-FACTOR CORRECTION frequently presents large possibilities for cutting power costs, as was the case at the two plants of Campbell, Wyant & Cannon Foundry Co, Muskegon, Mich. A substantial amount of electric power is purchased and used principally for operating electric furnaces, a special inductive-heating operation, and several hundred motors.

Freyn Engineering Co was retained as consulting engineer to determine how electric-power costs might be reduced. A survey led to the decision to continue purchase of power, but a change of rates was obtained and advantage taken of possibilities to qualify for lower-cost service.

This load is at a maximum in the morning, at the same time that the utility's peak occurs, so that the rates penalize demands at that time. The demand charge is based on kva integrated over 15-min intervals. Since plant power factor was low, demand charge was a dominant factor in the total bill, which made power-factor correction desirable. Capacitors were considered, but it was decided to install a synchronous condenser, because a suitable used unit could be purchased at low cost. Other factors affecting the choice were:

1. Power-factor correction is only necessary during morning hours.
2. The synchronous condenser would assist in improving voltage regulation of the plant, which was unsatisfactory because of severe load fluctuations and unbalanced single-

phase low-power-factor load of induction heating.

3. The plant is some distance from the power company's substation and is supplied over lines having considerable reactance.

4. Installation of the synchonous condenser incorporated needed improvements in switching and protection.

The new unit comprises a 2000-kva, 7200-volt synchronous condenser, a 4-panel switchboard and a flexible double bus switching layout using one oil switch per circuit, Fig. 1. Two of the four panels in the switchboard belong to the power company. These panels control the two incoming circuits and include totalling energy and reactive-component meters. The other two panels control the synchronous condenser and the plant-feeder circuits.

Oil Switches

Electrically-operated oil switches of 150,000-kva rupturing capacity are mounted on a pipe structure. Buses and connections are of substantial construction with liberal barriers between phases at points of exposure. The general appearance of the structure is shown in Fig. 2. The substation building is an enlargement of a brick building previously housing a simple switching and metering installation. The new switchboard and structure were erected without disturbing the existing installation. Connections were cut-over on a week-end without delay to production, after which the old installation was then removed, and the synchronous condenser erected in the space made available. Air drawn in through filters and delivered by a fan to the pit below the synchronous condenser, ventilates the substation, which is under a slight positive pressure. Large ventilators in the roof permit exit of warm air.

Schedule of Operation

The synchronous condenser is started at 9.00 AM, and excited to deliver maximum corrective kva until about noon. Under these conditions it raises the power factor about 15 points to about 92% and correspondingly reduces kva demand. During the afternoon, excitation is decreased and operations proceed at about 85% power factor. Under those conditions the billing demand is less than in the morning. Voltage regulation is satisfactory and the copper losses in the synchronous condenser are reduced. Late in the afternoon, as the load drops off, the synchronous condenser is shut down. Savings in power cost resulting from this change will return entire substation investment in a short time, and thereafter produce a handsome net savings in power cost.

Fig. 1—Two of the switchboard panels are for the incoming lines and two control the synchronous condenser

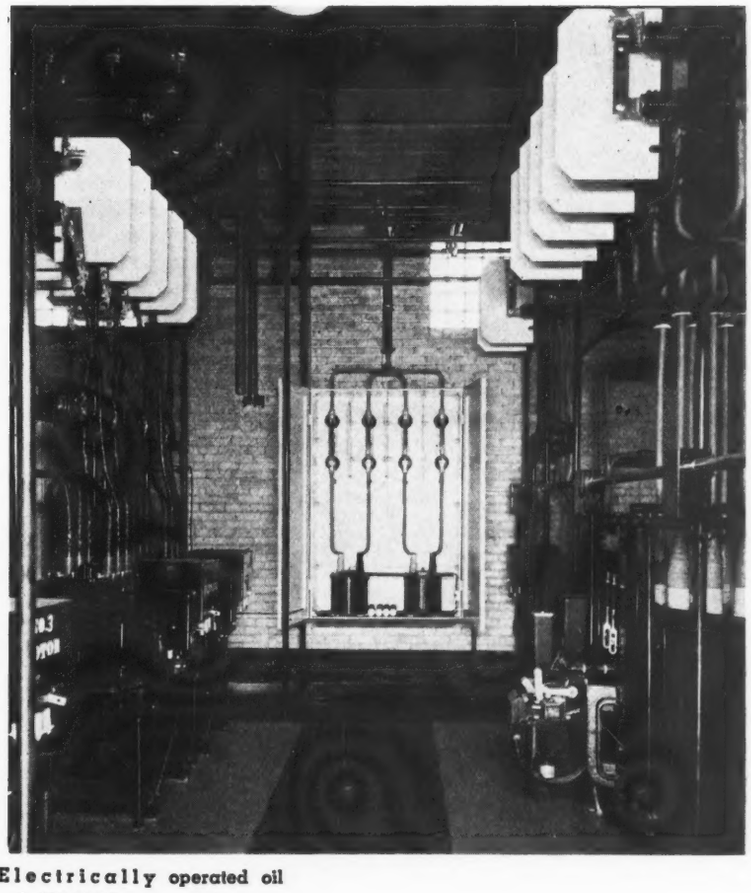
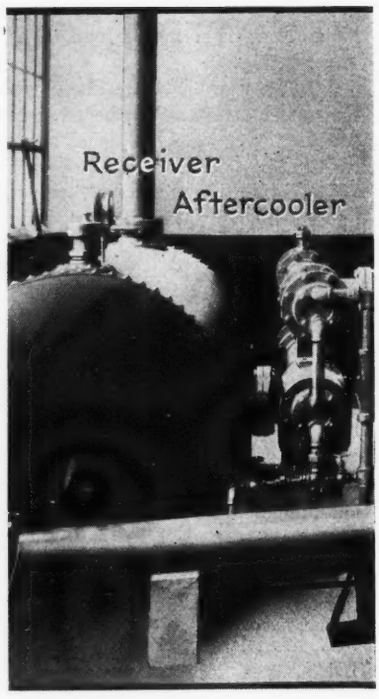


Fig. 2—Electrically operated oil switches of 150,000-kva rupturing capacity are mounted on a pipe structure

TO protect life and insure good air service, take care in the selection and installation of equipment beyond the compressor



Look Beyond the **Air Compressor**

By Harry Spring

A SUCCESSFUL compressed-air plant is one in which all parts of the system are properly coordinated. Beyond the compressor selection, proper installation and care of auxiliaries such as receivers, piping, gages and protective equipment, contribute in a large measure to satisfactory and safe operation.

A compressed-air receiver prevents air-pressure pulsations produced by the compressor from continuing through the system to the point of application. It should also provide enough storage capacity to prevent appreciable loss of pressure on demand peaks. The greater the demand fluctuation, the larger should be the receiver. If the compressed-air piping is large enough to maintain low flow velocity, it may be included as storage capacity.

In general, the receiver should be large enough to hold one minute's full-load output of the compressor.

Use the formula

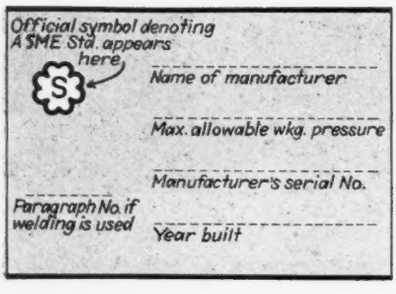
$$V_2 = \frac{14.7 \times V_1}{P_2 + 14.7}$$

where V_2 is the volume of air in cfm at compressed-air pressure, V_1 is maximum compressor-piston displacement in cfm and P_2 is gage pressure of the compressed air. For example, with a compressor having a maximum piston displacement of 125 cfm, an operating pressure of 100 lb per sq in is desired. Substituting in the formula:

$$V_2 = \frac{14.7 \times 125}{100 + 14.7} = 16 \text{ cu ft}$$

If a receiver 24 in. in diameter is chosen, a length of slightly over 5 ft would be the minimum requirement. This tank would probably be too small for any but a nearly constant load. A practical installation for average loads would perhaps use a receiver 30 in. in diameter by 5 or 6 ft long to insure adequate storage capacity and pulsation-dampening effect. There is no harm in choosing a receiver a little too large.

Fig. 2—Form of stamping used to identify unfired pressure vessels constructed according to ASME Code



Capacity and Output

Comparing the question of air-tank capacity and air-compressor output capacity per min, I find that several typical installations operating satisfactorily under reasonably steady loads average about 1 cu ft of receiver per 4 cfm of compressor capacity. In other words, an air compressor rated at 100 cu ft of free air per min would require a 25-cu ft air receiver, assuming the average amount of pressure piping and a load which did not vary greatly. With very short piping, the receiver volume should be about 10% greater. Conversely, extensive pressure piping of large diameter would permit using a smaller receiver.

Here are two satisfactory ways to control a highly fluctuating load which demands practically constant pressure. First is a secondary receiver installed near the load. This receiver acts as an accumulator, and should be of sufficient volume to supply the load with the maximum predetermined pressure drop. The second method is to operate a properly designed and constructed air receiver at a considerably higher pressure than required at the load, supplying the load through a reducing valve set at the correct load pressure. A relief valve set at the maximum pressure allowed on the load should always be installed after the reducing valve to prevent excessive pressure should regulator stick open.

Safety requires that air receivers be substantially constructed for the desired pressure. Select receivers constructed according to the ASME Code for Unfired Pressure Vessels, identified by a stamp on the receiver which complies with paragraph U-66 in the Code. Fig. 2 shows this form of stamping, which should use letters and figures at least $\frac{5}{16}$-in. high and should appear on some conspicuous part of the tank. The stamp is placed near a manhole, if any, or near a handhole, or on a nameplate, brazed or otherwise irremovably attached to the shell plate.

Some localities have adopted laws making it illegal to install a compressed-air tank not bearing the stamp of a required standard. It is important to investigate and comply with the local laws. If the installation is to be in a section not having a law, it will be safe and advisable to insist on a tank bearing the ASME Code stamp.

When a receiver is set vertically, it should be supported by three or more lugs, by a supporting ring under the lower head, or by any substantial construction that will permit inspection of the bottom head. Deterioration by external corrosion may progress unseen to a dangerous point under certain conditions, unless this type of mounting is used. If one head is convex and one concave in a

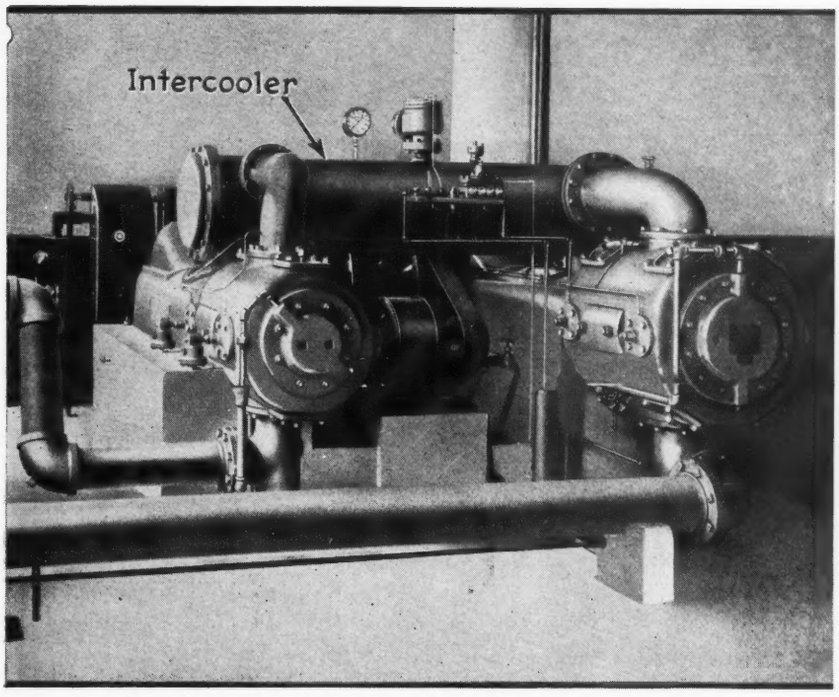


Fig. 1—Compressed-air plant with a 2-stage synchronous-motor-driven compressor, aftercooler and receiver

vertically mounted tank, it is well to have the convex (dished out) head at the bottom to facilitate drainage. Fig. 3 shows a correct installation of an air compressor with appliances and appurtenances, including a satisfactory mounting for a vertical receiver.

A horizontal receiver should not rest directly on brick, concrete, or wooden supports. Dampness (from sweating or other causes) may produce serious external corrosion at the point of contact. If supporting piers of these materials are used, cradle the tank on substantial metal shims. Give a horizontal tank a slight pitch to allow proper drainage.

The Massachusetts Department of Public Safety requires that a fixed ladder or footholds be provided in vertical air tanks over 6 ft high, when there is a manhole in the upper head. This is to assist ingress and egress by inspectors or the maintenance crew that might enter the tank for cleaning or repairing. This practice is conducive to safety and convenience, and is recommended for all installations of similar type.

Provide one or more safety valves for the compressed-air system and set them at a pressure not exceeding the lowest pressure stamped on any tank in the system. They should have discharge capacity to handle maximum compressor output without the pressure going above the allowed value.

Locate safety valves as close to the compressor as practical. Do not put shutoff valves of any description between the safety valves and compressor. Use no safety valve over 3 in. in diameter for compressed air. Do not use safety valves having cast-iron valves or valve seats. If a 3-in. safety valve will not relieve the system properly, use more than one valve. Use safety valves of the direct spring-loaded design, provided with a substantial lifting lever, preferably of a type marked "ASME Std". If safety valves are exposed to freezing temperatures, provide them with a $\frac{3}{8}$-in. drain at lowest point where water can collect.

Provide a blowdown or drain connection, at least $\frac{3}{4}$ in. in diameter at the lowest part of the air receiver. Do not use globe valves in this connection. Remove oil, condensation, corrosive sludge, and carbonaceous sediment from the tank by blowing down through this connection once daily.

When the safety-valve setting exceeds 50 lb per sq in. and the compressor capacity exceeds 50 cfm free air, it is advisable to provide fusible plugs. These melt and give warning when the air temperature reaches 500 F, a dangerous operating condition that should be corrected immediately. Place a fusible plug in the discharge line close to the compressor, and one at the highest part of each primary air receiver, as in Fig. 3. *Use fusible plugs designed for compressed-air service and not of the boiler type.* Those stamped "Mass. Std." are satisfactory.

Pressure Gages

Provide at least one pressure gage calibrated to not less than 1.5 times safety-valve setting. Brass pipe and fittings are recommended for pressure-piping. Put a $\frac{1}{4}$-in. valved connection in the piping so that pressure-gage accuracy may be determined by a test gage while the system is in operation. Unless the pressure gage is exposed to freezing temperatures, provide a syphon to fill the gage tube with water to prevent damage by high-temperature air.

Piping between the compressor and aftercooler, if any, and the receiver should not be reduced below compressor discharge diameter. A minimum number of sharp turns is desirable. Sharp turns cause friction and result in backpressure and power loss at the compressor, and reaction of the piping to air-flow pulsations may cause dangerous pipe-line pulsation. Anchor the piping along at least two axes.

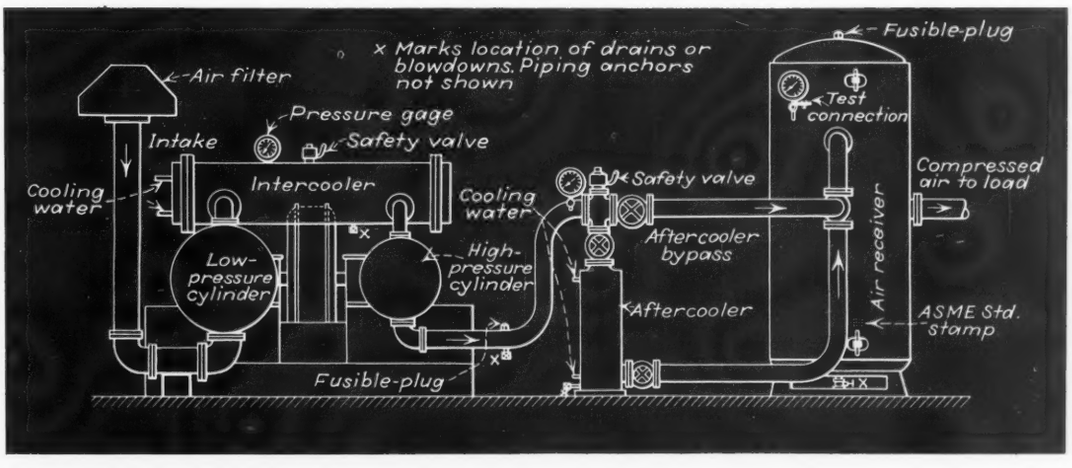


Fig 3 — Air-compressor auxiliary equipment correctly installed and protected. Receiver is mounted so that its bottom can be properly drained and inspected

Versatile Turbine

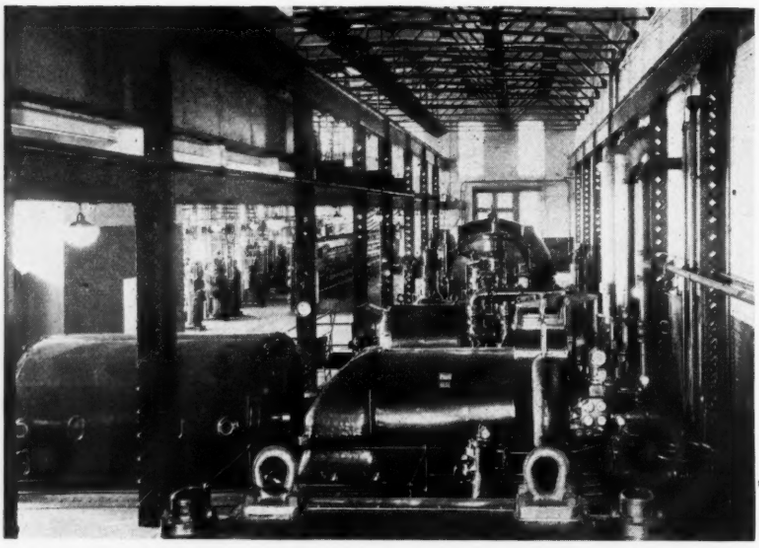


Fig. 1—Turbine room of the municipal plant at Holyoke, Mass., showing the new turbine-generator in the foreground

For inlet steam pressures from 190 to 450 lb, condensing or backpressure, feed-heating only or automatic bleed, this turbine does everything but fly

By T J McGrath

WESTINGHOUSE ELECTRIC & MFG CO
SOUTH PHILADELPHIA

MODERN turbines can be designed to satisfy diverse requirements. The Holyoke turbine, a case in point, is intended for normal steam conditions of 210 lb, 150-F superheat and 29-in. vacuum, but can operate at other pressures without serious impairment of efficiency when present and future plant conditions require. Here's what it can do:

1. Generate 6250 kw at 100% power factor with 190-lb, 125-F superheat steam at 28½-in. vacuum.
2. Generate 5500 kw with 210-lb, 150-F superheat steam at 2-lb g backpressure.
3. After predetermined changes, the unit will operate efficiently at 450 lb, 150-F superheat and 29-in. vacuum.
4. Operate as a mixed-pressure turbine with 450-lb and 210-lb steam, generating 5500 kw at 2-lb g backpressure.
5. Operate on 210-lb steam after the changes, generating 5500 kw at 2-lb g back-pressure.
6. After installation of automatic bleeder mechanism, with 450-lb steam pressure, bleed at 125 lb when operating at vacuum.
7. Supply three stages of feed heating with present or future steam conditions.

These wide variations in operating conditions are required by plant changes. Older turbines now in operation have cast-iron parts which temporarily limit operating pressure to 190 lb. This limitation will be removed in the near future and the pressure raised to 210 lb. Furthermore, condensing water is taken from a canal which is drained for cleaning and repairs for one or two weeks each year; during this period the unit must exhaust to atmosphere.

When new boilers are installed, the station pressure may be increased to 450 lb and the turbine changed to operate at the higher pressure. The present plan is to install sufficient high-pressure boiler capacity to operate the unit condensing and retain low-pressure boilers enough to supply the additional steam needed when noncondensing.

An anticipated demand for 125-lb steam in the future led to the provision for adding automatic bleeding control.

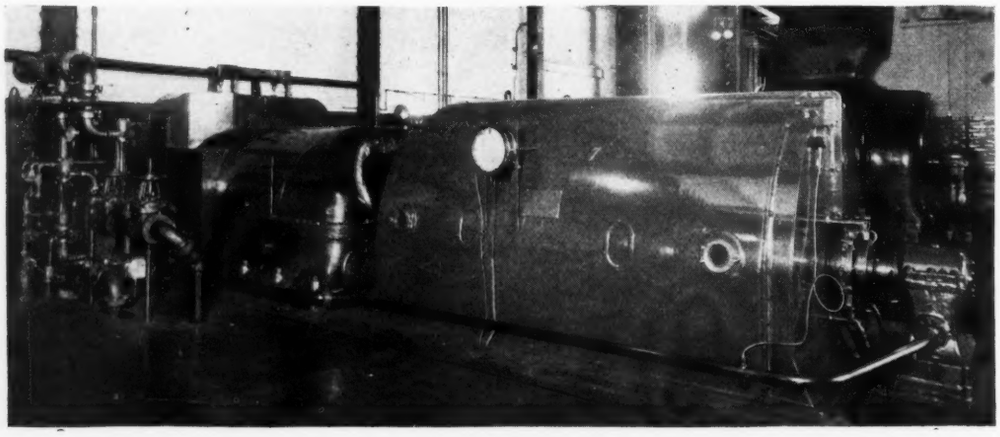


Fig. 2—Compact 5000-kw, 3600-rpm turbine can be adapted to future boiler-plant changes which will raise steam pressure from 210 lb to 450 lb

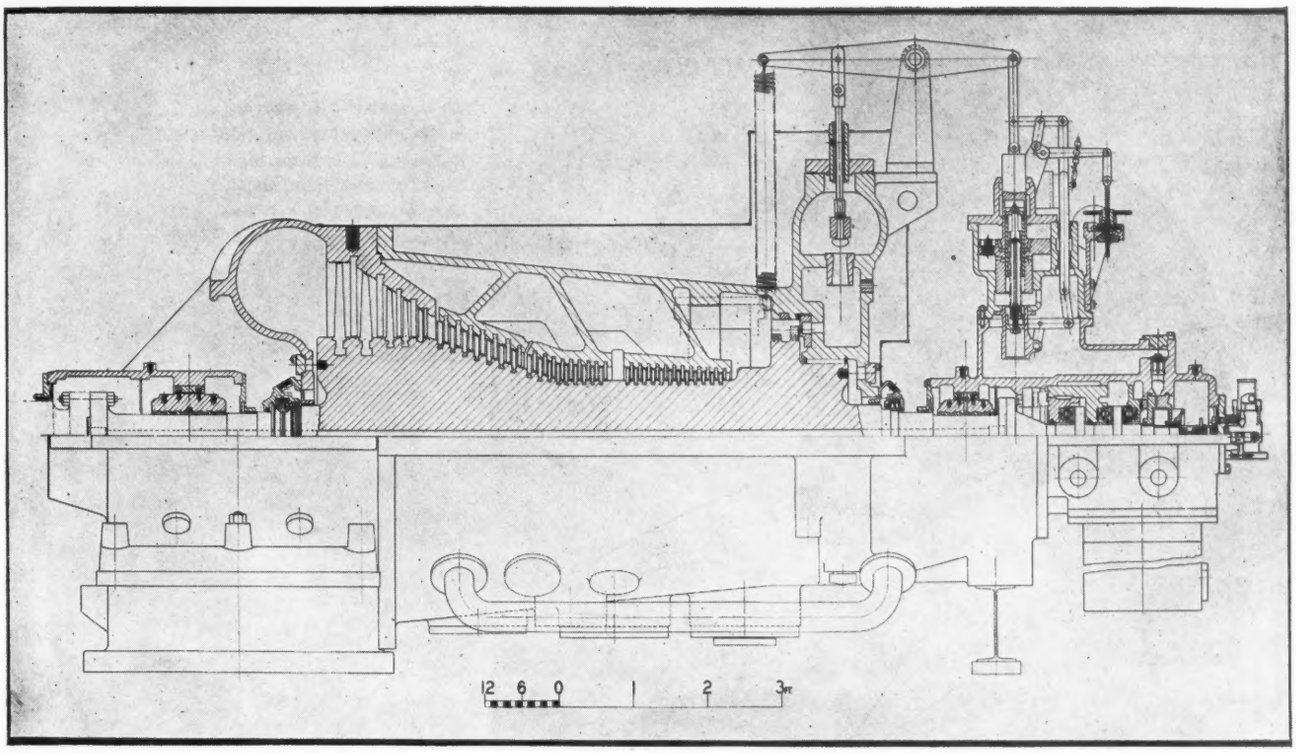


Fig. 3—Cross-section of turbine shows plugged impulse blade rows and governing arrangement

The cylinder and rotor are machined to provide for a 2-velocity-stage impulse element, but only one row of blades is installed; grooves for the other row are plugged. Later, when changes are made to adapt the turbine for higher pressure, the present impulse blades and plugs will be removed and the blades for a 2-velocity-stage impulse element installed without additional machining of the cylinder or rotor. The 33 stages of reaction blading are divided into four groups with suitable openings for extraction for feedwater heating. Blades, ½ in. wide, are of rolled stainless steel with brazed-on packing pieces. Larger blades are machined from bar stock and have integral roots.

Non-Condensing Operation

Non-condensing operation is the same as condensing until the seven control valves are wide open and the steam flow is 72,000 lb per hr at a load of about 2200 kw. As the load increases above this point, steam passes through the end of the steam chest and an external pipe to a bypass valve located at the side of the turbine. Operated by a separate mechanism, this valve admits steam to the 14th reaction stage. Gradually, as more steam is bypassed on increasing load, flow through the higher stages decreases to that just sufficient to cool the blading.

When the turbine is converted for high pressure, the present 10-in. throttle valve and steam strainer will be connected directly to the bypass valve to control the low-pressure steam for mixed-pressure operation. A new 8-in. throttle valve and strainer will supply the steam chest. Entirely separate sources of supply eliminate possibility of excessive steam pressure on the cylinder walls. New valve seats and nozzle blocks will also be required.

Automatic Bleeding

For automatic bleeding, the first three stages of reaction blading must be removed along with four inches of the high-pressure cylinder blade ring in order to machine groves for installing grid valves. The cylinder can be machined in place by a portable boring bar supported in the small bore of the cylinder end walls. The dummy piston between the impulse element and the reaction blading can be grooved for sealing strips by turning the spindle in the turbine bearings and supporting the cutting tool in a holder fastened to the cylinder.

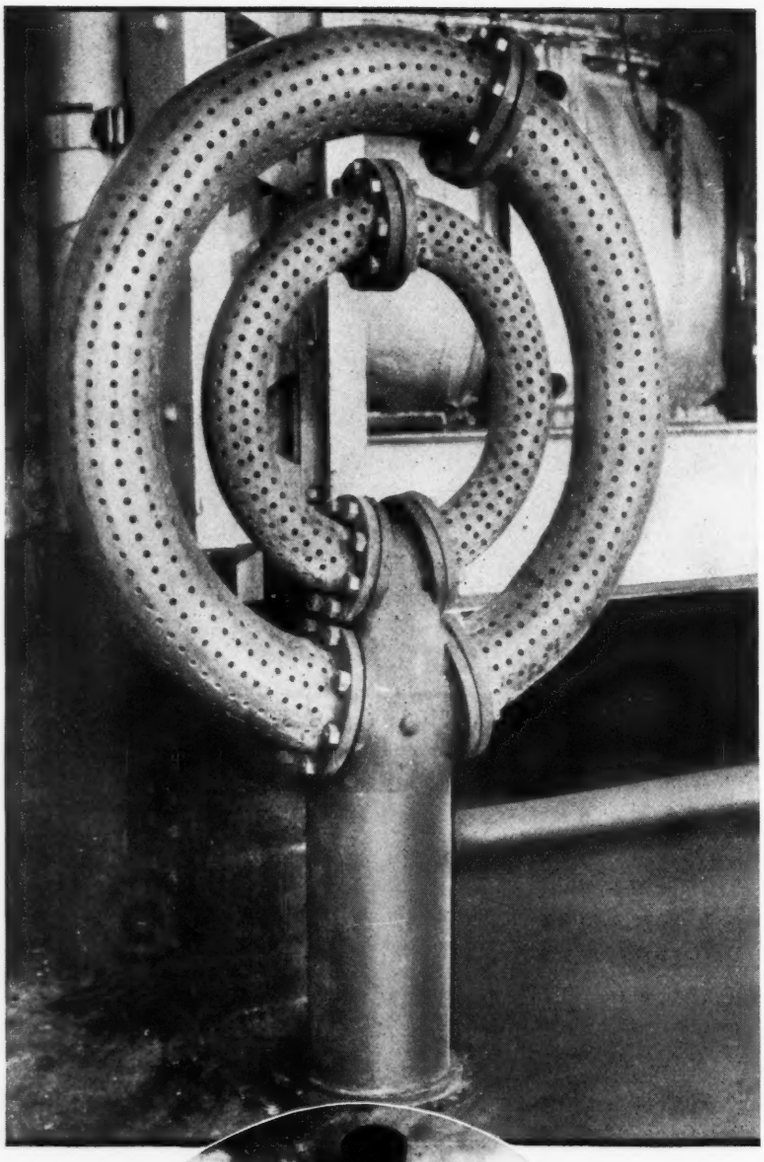
Two separate governor-operating mechanisms are provided, one controlling the steam-chest valves and the other the bypass valve. Both have motor-operated speed changers controlled by interlocking limit switches. The bypass-valve speed changer is connected to the control circuit just before the main one is disconnected and vice versa. A 1% change in speed is allowed between connecting one and disconnecting the other so the bypass valve will open when the speed falls that amount below normal. Only a small overlap is allowed to limit overspeed on sudden loss of load.

The condenser is fastened directly to the turbine exhaust. It has 6250 sq ft of Muntz metal tubes of 11 ft, 10½ in. active length. Tube plates are also Muntz with tubes rolled in at both ends. The condenser shell is larger in diameter than the tube plates, connection being made by ¼-in. end plates which take care of differential expansion between the tubes and the shell. The welded-steel condenser shell is ½ in. thick. Waterboxes and covers are cast iron. The atmospheric relief valve is opened manually when the turbine operates non-condensing and serves as the exhaust outlet.

Extensions at the Holyoke plant were made under the direction of J F Kirkpatrick, manager, Gas & Electric Dept, Holyoke, Mass., and C H Craig, McClintock & Craig, engineers.

Oil From Waste

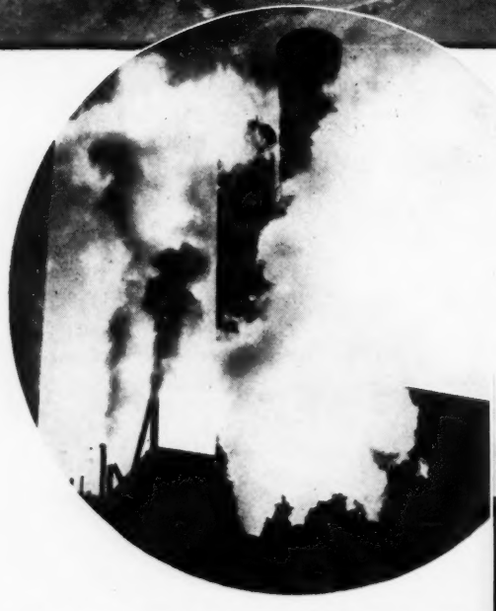
Germany's acute fat shortage has turned industrial interest toward development of grease and oils from waste. It is estimated that for each 100,000 people, from 180 to 365 tons of crude fat are obtainable annually from sludge. Of the 80,000 tons of grease flowing into sewers each year, Germany hopes to reclaim 25,000 for the manufacture of laundry soap.

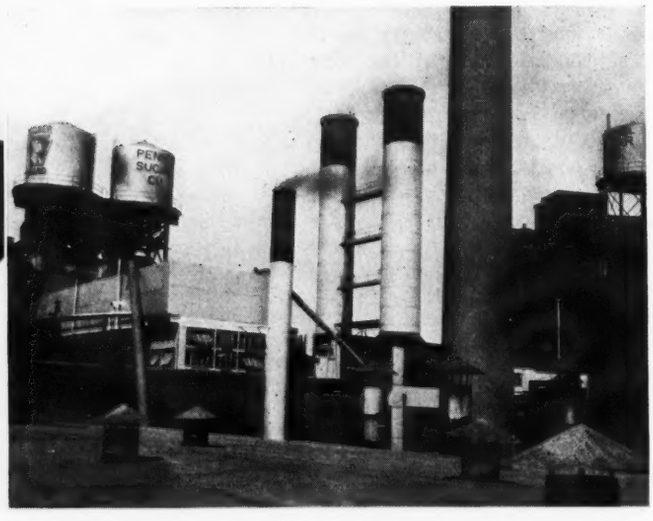


This "pretzel", or sparger, feeds exhaust steam into a beer still (which separates alcohol from slops), saving 17,000 lb of live steam per hr

Steam-Saving **Pretzel**

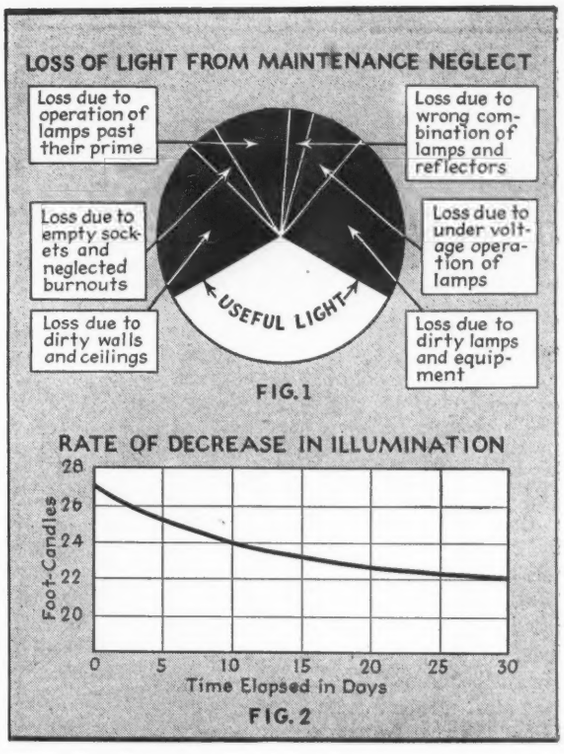
PENNSYLVANIA SUGAR CO., Philadelphia, during weekend shutdowns, had been wasting exhaust steam. This sparger recovers 700,000 lb of exhaust a day for alcohol separation (replacing live steam), yet cost only $1,805.42 with control valves. It is made up of 6- and 8-in. copper tube containing 866 $\frac{3}{8}$-in. holes and mounted on an 8-in. section cast from copper reclaimed from old plant trolley wires.





Before (above) and after (right) the alcohol plant began to use exhaust, saving the equivalent of 800 hp per hr in live steam. A new gas washer reduced smoke emission from two 200,000-lb-per-hr boilers below that of the char house (foreground)

Fig. 1—Loss of light from maintenance neglect. Fig. 2—Rate of decrease of illumination from dirt accumulation



Getting the Most Out of Your **Lumens**

A planned maintenance program will bring down the lighting bill. Here is shown what to do and how to do it

By Samuel G Hibben

WESTINGHOUSE LAMP DIVISION
BLOOMFIELD, N. J.

THE HIGH COST of poor maintenance is nowhere more insidious than in lighting. Low voltage, improper or aged lamps, dusty reflectors, dirty walls and ceilings, and empty sockets may singly or in combination take their toll, with the result that many plants do not get the illumination they pay for. Here are the things to watch:

Keep Bulbs and Fixtures Clean—Bulbs and reflectors should be wiped free of dust at least once a month, and except in unusually dirty locations, they should be washed at least once every 60 days. Stubborn cases of encrusted, greasy dirt require warm water and soap or a mild grease solvent. Extreme cases of hardened, sooty deposits, particularly on outdoor surfaces, may require a dilute solution of oxalic acid. After washing, wipe and dry reflectors carefully or rinse in ammonia water to avoid the soap film that will hold the next deposit of dust.

Wash Dirty Walls—What has been said about dirt on reflectors and bulbs applies in principle to grimy or discolored interior surfaces. It is common practice, and economical, to wash most painted interiors once a year.

Use Efficient Lamps—A common item of lighting maintenance concerns lamps of poor quality. The cost of the bulb is merely a small down payment on the cost of lighting, usually representing less than 10% of the total. A few cents difference in the cost of the bulb is really negligible, whereas a few per cent difference in output efficiency is vitally important. If we evaluate lighting costs properly, we find that a deficiency of 6% in lamp efficiency is about equal to the average first cost of the lamp. Hence, inefficient lamps are not cheap at any cost.

Empty Sockets Are Expensive—Fixed charges, such as cost of installation and investment, continue whether the socket is empty or full. Obviously the unobserved burnout is doubly to be avoided because if the unit appears to be ready for service and yet fails to function in an emergency, it represents a definite loss, sometimes an accident hazard.

Pension Aged Bulbs—Aged lamps in a properly maintained system should be removed even though still capable of burning. Happily, most American lamps of high standing do not frequently blacken seriously enough to necessitate removal before burnout.

Maintain Correct Voltage—To a minor degree, there may be some loss in voltage due to any corroded contacts throughout the system. To a greater degree, there is a voltage loss resulting from haphazardly extending or overloading branch circuits, a temptation that exists through practicing the false economy of saving a little copper at the cost of lumens.

The voltage drop in any system should not exceed 2%. In the main, this is counterbalanced by providing a slightly excess voltage at the service entrance or the distribution panel. The cost evaluated in units of light amounts to approximately 3% dimunition of illumination for a 1% drop in voltage. By over-voltage burning, you gain light at the cost of life.

Keep Reflectors and Bulbs Matched—If the glass reflector is broken, light is wasted sidewise, because the proper reflector usually increases the usable light from two to three times over that from a bare lamp. If the metal reflector becomes tarnished or bent, much the same thing occurs. If, and this is important, the wrong size of lamp bulb be inserted in a reflector, then the emitted beam is changed, and the combination loses effectiveness.

Plan Inspection Schedule—In this, as in all equipment maintenance, the secret of efficiency lies in *planned periodic attention*. The maintenance should be made the regular duty of a reliable employee.

Speaking of POWER

PHIL SWAIN . . . . . Editor

IN DECEMBER, I took a trip to Pittsfield, Mass., in the heart of the beautiful Berkshires, to see General Electric's new plastic-molding plant. With 320 presses, this is, I believe, the largest plastic-molding plant in the world. Compounds, in powder form, are hydraulically squeezed between the two halves of heated steel molds. . . . From this trip I brought away two outstanding impressions: 370-F water to heat the molds is drawn directly from the boiler drum and pumped throughout the factory under 200-lb pressure to prevent it from flashing into steam. You will find technical details of this sensational process described on page 8. This is the second installation of its kind in America, but the largest. Here is a new power service, "superheated water," something which will interest many industrial engineers. . . . My other impression is of the enormous tool room, almost as large as the press room itself. Here were row on row of ultra-modern machine tools and scores of superskilled workmen carving intricate dies out of blocks of tool steel. In this I see still another answer to those who imagine that the machine destroys skill and makes automatons of men. The present trend is just the reverse. . . . If ever we have the so-called "manless factory" it will be manless only in the sense that the workers will all have graduated from the brainless jobs to those requiring a noodle.

. . . . carving dies

. . . . clinging vine

From the facing page, you will see that the clinging vine has at last become a piece of power-plant equipment. We have first-hand testimony from our own photographer, who was there, that this is no fake. Good old turnbuckle vine! Maybe the climate down at Fort Oglethorpe, plus the comforting warmth of the stack has something to do with it.

Engineering grows more scientific every year, yet I doubt whether we can ever get completely away from rule of thumb. We don't understand everything now and never will. Meanwhile we have to live, which means that we have to act without full understanding. . . . Where would we be today if men had waited for theoretical understanding before making practical application? How about the sailing ship? How about steam engines and boilers? Just look back over history and see how often some go-getter did the job years before the theorists came along and explained why it worked. And let's not forget the old colored mammy. She can't tell a steam table from a hot plate and thinks degrees Fahrenheit are lodge ritual, but her pies taste mighty good, just the same.

. . . . a steam table

Speaking of climate, I must join those who "point with pride" to the California variety. Even schools grow bigger out in the West where men are men and the sun shines perpetually. If you don't believe it, turn to page 40. With its 40-acre campus, that school at Fullerton, Calif., looks like a fair sized college. Buildings are connected by 4,000 ft of tunnel carrying lines for steam, hot and cold water, electricity, gas, sewage, public address signals and telephone. The last three remind us that talk, piped or wired, is one of today's standard power services.

Our question department, which is the whole *Power* staff, gets some tough ones. For example, a recent letter asked, "Where can I buy diesel farm-light sets, 32-volt sheep clippers and a 32-volt horse clipper?" And some folks call this age horseless!

A Dutch uncle recently wrote in about his hydraulic piping. Pressure is 1500 lb and line 400 ft long. Not a leak in 15 years. For your practical information, the joints are male and female, copper gasketed.

The foreword (page 1) bids the good old coal shovel "Rest in Peace" while the article on page 10 is titled "Good Bye Coal Shovel." Looks like collusion. As a matter of fact the two just happened to hit the same issue. The darkey shoveler gave me my hint for a sermonette, while another member of the staff, quite independently, hit upon an apt title for an excellent article on coal handling in small plants. Let's sum it all up here by saying that the shovel is dead in modern plants, large or small.

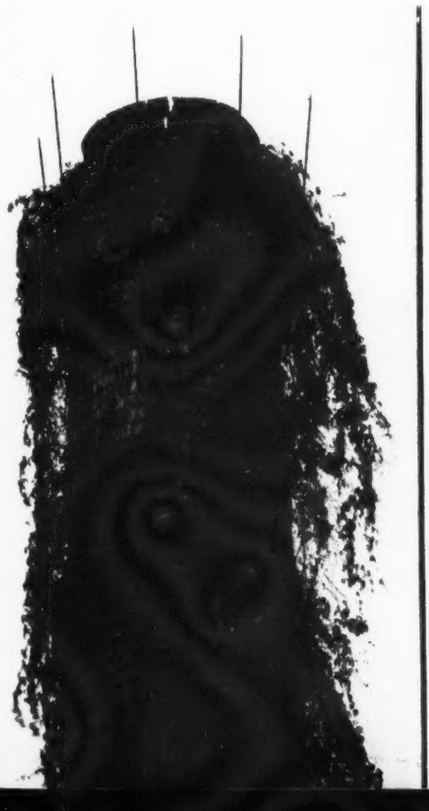
. . . . good bye shovel

December's special section on *Fluid Highways* has left several of the editors woozy, but their efforts are repaid by the number of readers who have found useful information in it. We knew that piping, valves and fittings were of vital interest to every engineer, and that developments over the past three years had changed the picture materially— which meant simply that we had to take our own medicine. We've preached the doctrine of obsolescence in power equipment; it also holds on *Power* articles —for confirmation, compare the *Piping* Section in February, 1935, with that of December and Mid-December, 1937.

Another subject has been taking tremendous strides in the last three years—air conditioning. In April, 1936, we told what air conditioning was all about, showing that it was little more than a new combination of units long familiar to power engineers. In February, we're going to carry on, bringing air conditioning up to date, describing commercial units, showing types of installations, sources for equipment, and so on. We asked, diffidently, for lists of installations since Jan. 1, 1936, and are swamped with the reply. We have already tabulated several hundred installations of all types, and as Cap'n Henry used to say, "It's only the beginning, folks, only the beginning!" Look for the results in February, if we live through it.

. . . . swamped with replies

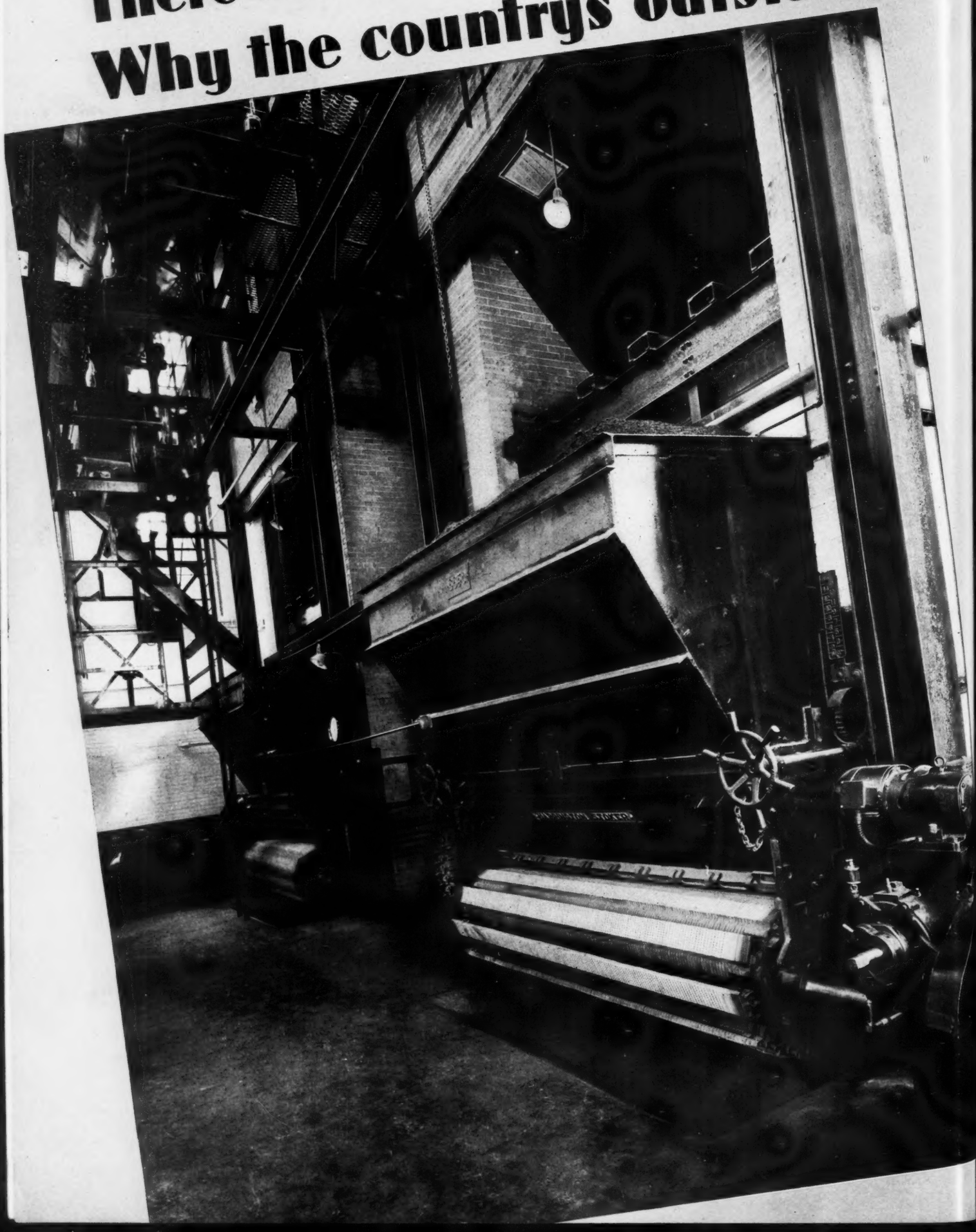
CREEPER CLINGS, CLAMPS CRACK



FOUR YEARS AGO, cavalrymen at Fort Oglethorpe, Ga., began to do their riding at a safe distance from the 125-ft brick power-plant stack, for a crack had appeared at its top and had worked down about 40 ft, something over 25 ft of it being opened out to a maximum of about 3 in. at the top. Engineer J F Masefield had asked for an appropriation to get the stack repaired, but it was moving at normal official speed. He mentioned his difficulties to a brother engineer down in Florida, who suggested he plant some slips of Florida vine at the base of the chimney. It sounded ridiculous, but Masefield carried three shoots back with him and tried them. One died, but the other two grew to the top of the stack within a year, encircled the crown, and actually began to pull the crack shut. Now, four years later, the vine is over 3 in. in diameter and the crack is closed, except for the little bit visible at the top of the stack. Our roving photographer heard the story, took the pictures, then had the facts checked by Major Williamson, commanding. It's all true.

P.S.—The appropriation hasn't come through yet.

There are many good reasons Why the country's outstanding



companies have recently ordered the Improved RILEY-HARRINGTON STOKER

There have always been many good reasons for the selection of Riley-Harrington Stokers when conditions dictated the use of traveling or chain grate stokers. Through improvements made in recent years, these reasons have been greatly magnified.

A new and vastly improved grate surface has been developed. This grate surface has shown increases in efficiency from three to seven per cent; has increased capacities up to fifty per cent; has reduced grate surface maintenance by half.

The air seals, both compartment and chain seals, have also been redesigned to assure tightness and prevention of air leakage at the side walls as well as from one compartment to another.

Driving sprockets, chains, pins and rollers are now made of special materials to assure long life and lower maintenance.

These and other improvements make the Harrington Stoker even more outstanding among traveling grate stokers today than formerly. They are a few of the reasons why Harrington Stokers continue to be selected by so many of the country's outstanding companies for burning anthracite, coke breeze, mid-western coals and lignite.

When traveling grate stokers are being considered be sure to investigate the Riley-Harrington Stoker.

A FEW OF THE COMPANIES WHICH HAVE RECENTLY ORDERED RILEY-HARRINGTON STOKERS

Ford Motor Co., Highland Park, Mich.
2–120,000 lbs. steam/hr. burning bituminous coal or 75,000 lbs. steam/hr. burning anthracite coal

Great Lakes Steel Corp., Detroit, Mich.
2–75,000 lbs. steam/hr. burning coke breeze

Otter Tail Power Co., Wahpeton, N. D.
1–130,000 lbs. steam/hr. burning lignite
Repeat order

American Brass Co., Kenosha, Wisc.
2–50,000 lbs. steam/hr. burning bituminous coals

Clifton Paperboard Co., Clifton, N. J.
1–150,000 lbs. steam/hr. burning anthracite
Repeat order

Tennessee Coal, Iron & R. R. Co., Fairfield, Ala.
1–50,000 lbs. steam/hr. burning coke breeze
Repeat order

Great Western Sugar Co., Billings, Mont.
3–125,000 lbs. steam/hr. burning Montana & Wyoming coals

No. Dakota Power & Light Co., Beulah, N. D.
1–56,000 lbs. steam/hr. burning lignite
Repeat order

Imperial Paper & Color Corp., Glens Falls, N. Y.
2–50,000 lbs. steam/hr. burning anthracite

Northwestern Public Service Co., Mitchell, S. D.
2–37,500 lbs. steam/hr. burning lignite
Repeat order

Pittsburg Terminal Coal Co., Horning, Pa.
2–36,000 lbs. steam/hr. burning bituminous coals
Repeat order

Overbrook Steam Heat Co., Philadelphia, Pa.
2–30,000 lbs. steam/hr. burning anthracite
1–80,000 lbs. steam/hr. burning anthracite
Repeat order

Elizabeth Consolidated Gas Co., Elizabethtown, N. J.
4–23,000 lbs. steam/hr. burning coke breeze
Repeat order

City of Macon, Mo.
1–20,000 lbs. steam/hr. burning bituminous coal

Stamford Gas & Electric Co., Stamford, Conn.
1–50,000 lbs. steam/hr. burning coke breeze

Hercules Powder Co., Kenvil, N. J.
2–40,000 lbs. steam/hr. burning anthracite

Northern Pacific R. R., Glendive, Mont.
1–22,000 lbs. steam/hr. burning Montana coal
Repeat order

Scoville-Oakville Co., Oakville, Conn.
3–25,000 lbs. steam/hr. burning anthracite
Repeat order

Finch Pruyn & Co., Glens Falls, N. Y.
2–50,000 lbs. steam/hr. burning anthracite

Griesedeck Bros. Brewery, St. Louis, Mo.
2–26,000 lbs. steam/hr. burning bituminous coals
Repeat order

Wynnefield Steam Heat Co., Philadelphia, Pa.
1–55,000 lbs. steam/hr. burning anthracite

Taishuyen Electricity Works, China
1–110,000 lbs. steam/hr. burning Chinese coals

John Eichler Brewing Co., New York City
1–45,000 lbs. steam/hr. burning anthracite
Repeat order

Note that over 50% of above orders are REPEAT ORDERS

RILEY

STOKER CORPORATION, WORCESTER, MASS.

BOSTON NEW YORK PHILADELPHIA PITTSBURGH BUFFALO CLEVELAND DETROIT TACOMA BALTIMORE ST. LOUIS CINCINNATI HOUSTON CHICAGO MILWAUKEE DENVER MEMPHIS ST. PAUL KANSAS CITY LOS ANGELES ATLANTA NEW ORLEANS

COMPLETE STEAM GENERATING UNITS

BOILERS - SUPERHEATERS - AIR HEATERS - ECONOMIZERS - PULVERIZERS
BURNERS - STOKERS - WATER-COOLED FURNACES - STEEL CLAD SETTINGS

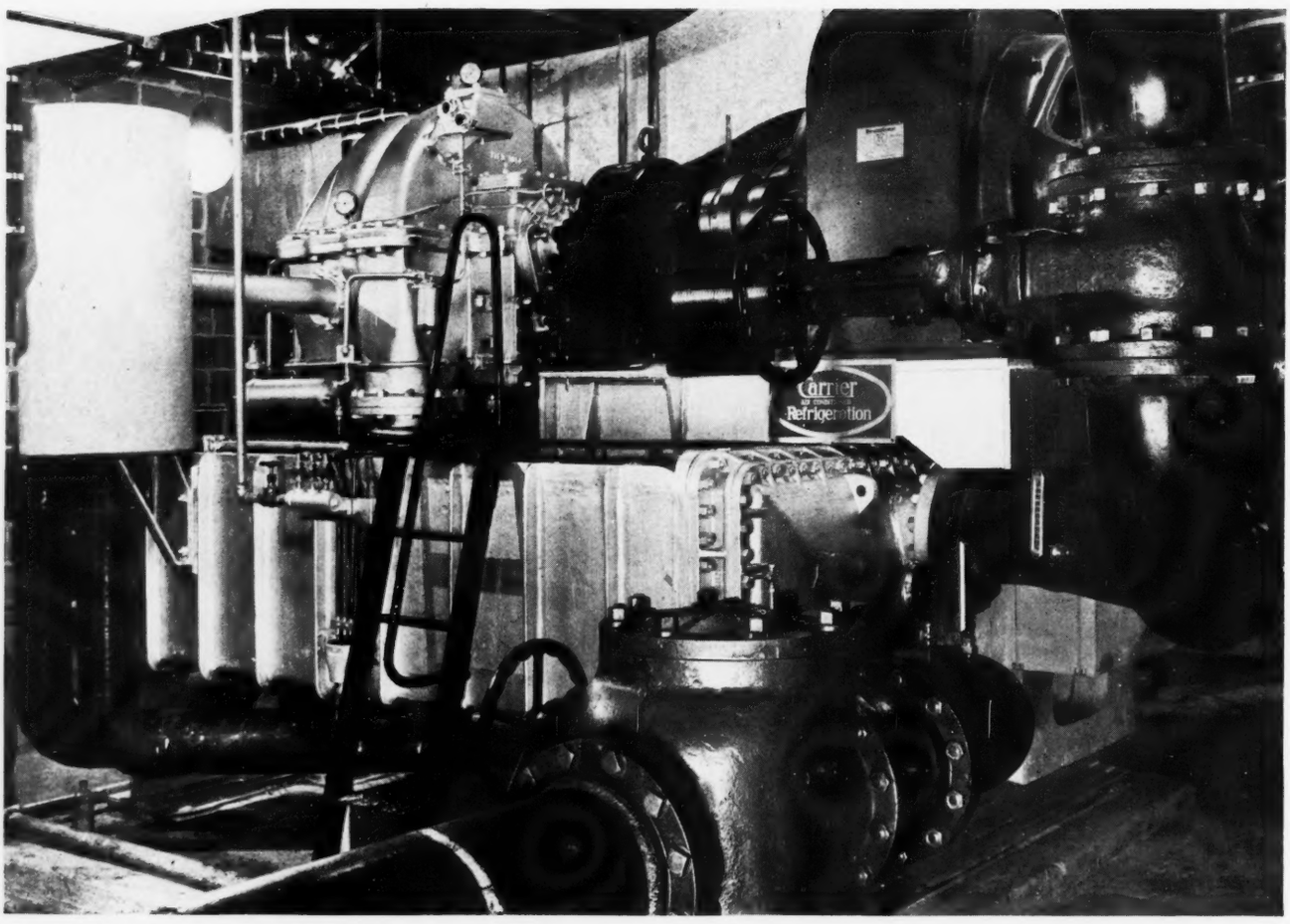


Fig. 1—850-ton Carrene centrifugal refrigerating machine. 350-ton unit is located immediately behind this one

8 ACRES OF SPRING

Multi-building Gimbel's department store in Philadelphia, air-conditions over 360,000 sq ft of floor space with two Carrene centrifugal refrigerating machines

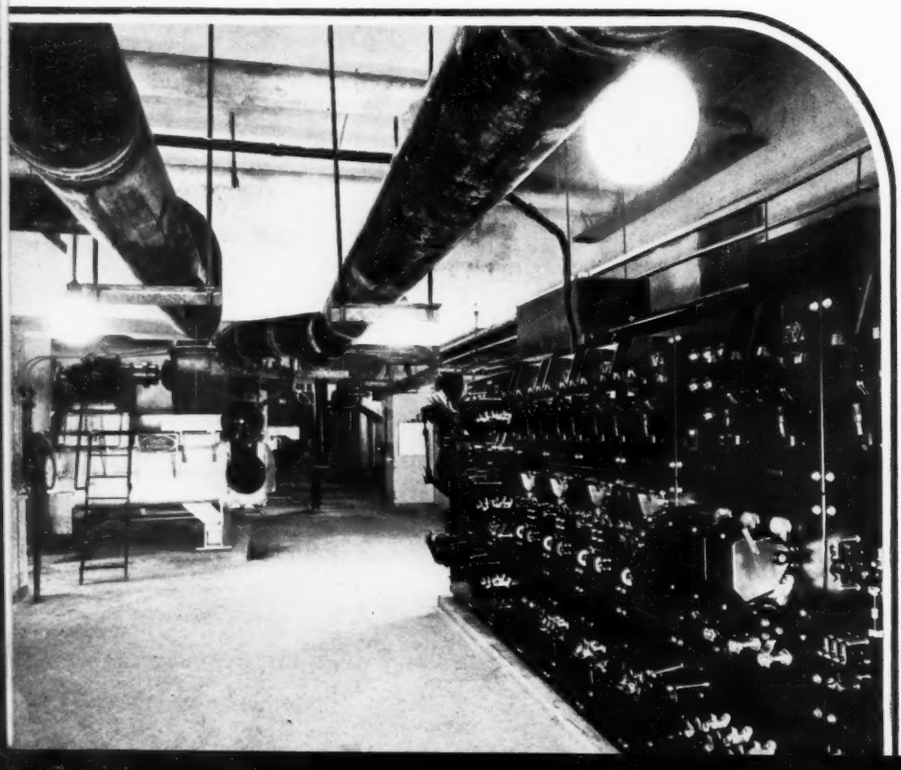


Fig. 2—Refrigerating room, showing instrument panel, piping and larger refrigerating machine

ONE OF THE LARGEST air-conditioning systems in the country is the recently completed 1200-ton installation at Gimbel Brothers' multi-building store in Philadelphia, Pa. Total areas served by the equipment is approximately 360,000 sq ft of floor space (about $8\frac{1}{4}$ acres) and includes four basement stores, four first floors, two second floors, three third floors and a seventh floor comprising the main dining room, English grill, and private dining rooms. Conditioned spaces are supplied with air from adjacent fans and dehumidifiers.

Chilled water for the dehumidifiers comes from the main refrigeration room in the sub-basement, Fig. 1, which contains two Carrier centrifugal refrigerating machines, one of 350 tons, the other 850 tons capacity, driven by

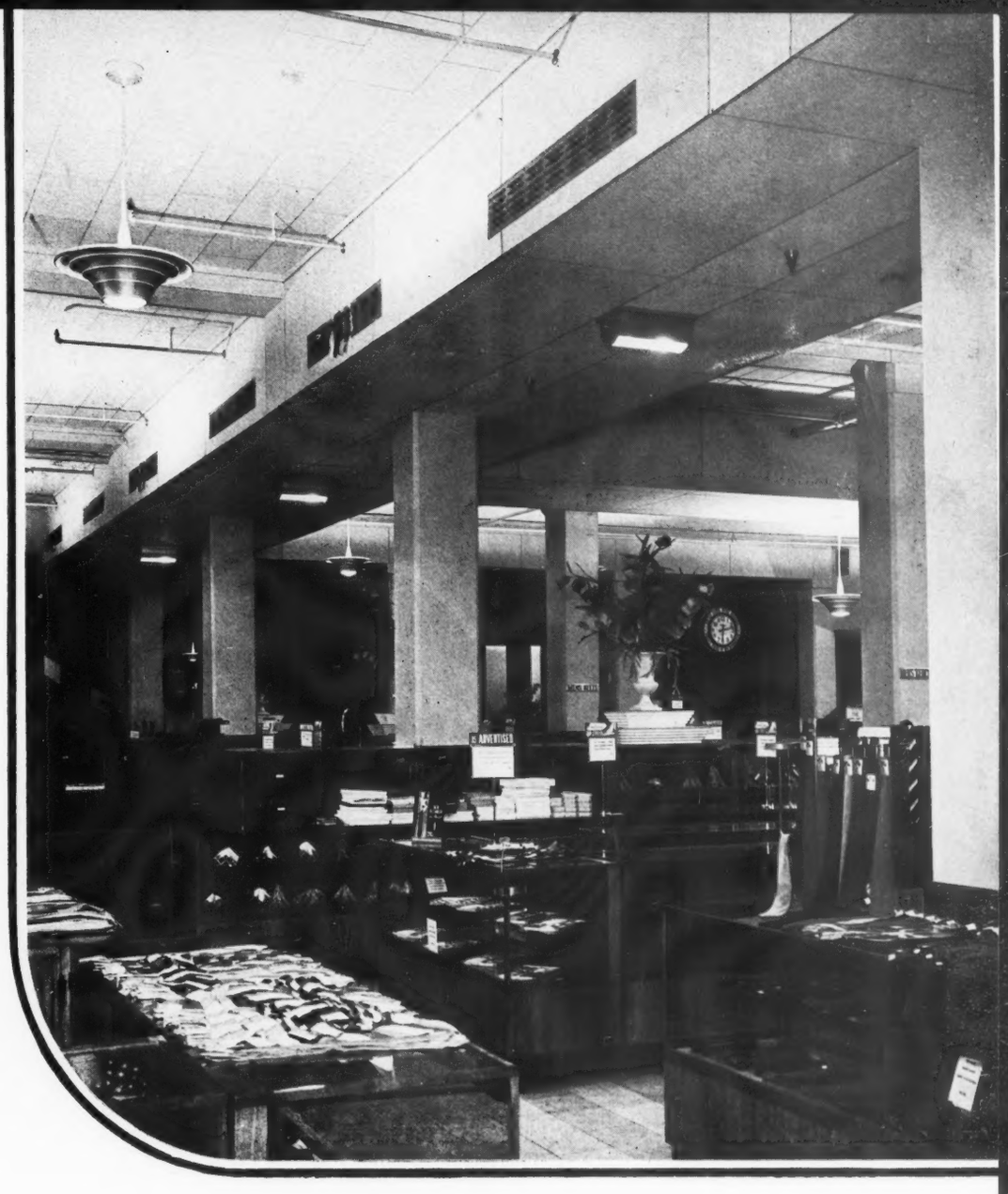


Fig. 3—One of the conditioned spaces. Note how ductwork matches building design

400- and 1000-hp Westinghouse motors respectively through Terry reduction gears. In these machines, compressed Carrene vapor is liquified in a shell-and-tube condenser with water from the cooling tower circulating through the tubes. The liquid refrigerant is then pumped into a cooler or evaporator and sprayed over tubes carrying recirculated water from the surge tank, where it evaporates and removes heat from this water, cooling it to 45° F for circulation to the dehumidifiers. This chilled water is delivered to the dehumidifiers by two 2100-gpm Allis-Chalmers motor-driven pumps. Nash motor pumps return water from dehumidifiers to surge tank.

Condensing water is cooled in a Marley roof tower, 13 floors above the street. Air is circulated in the tower by six Marley propeller-type fans, 9½ ft in diameter. The tower cools 4200 gpm of water from 93.5° F to 85° F in the hottest weather. The 20-in. condenser-water risers are oversized for a future increase in air-conditioning.

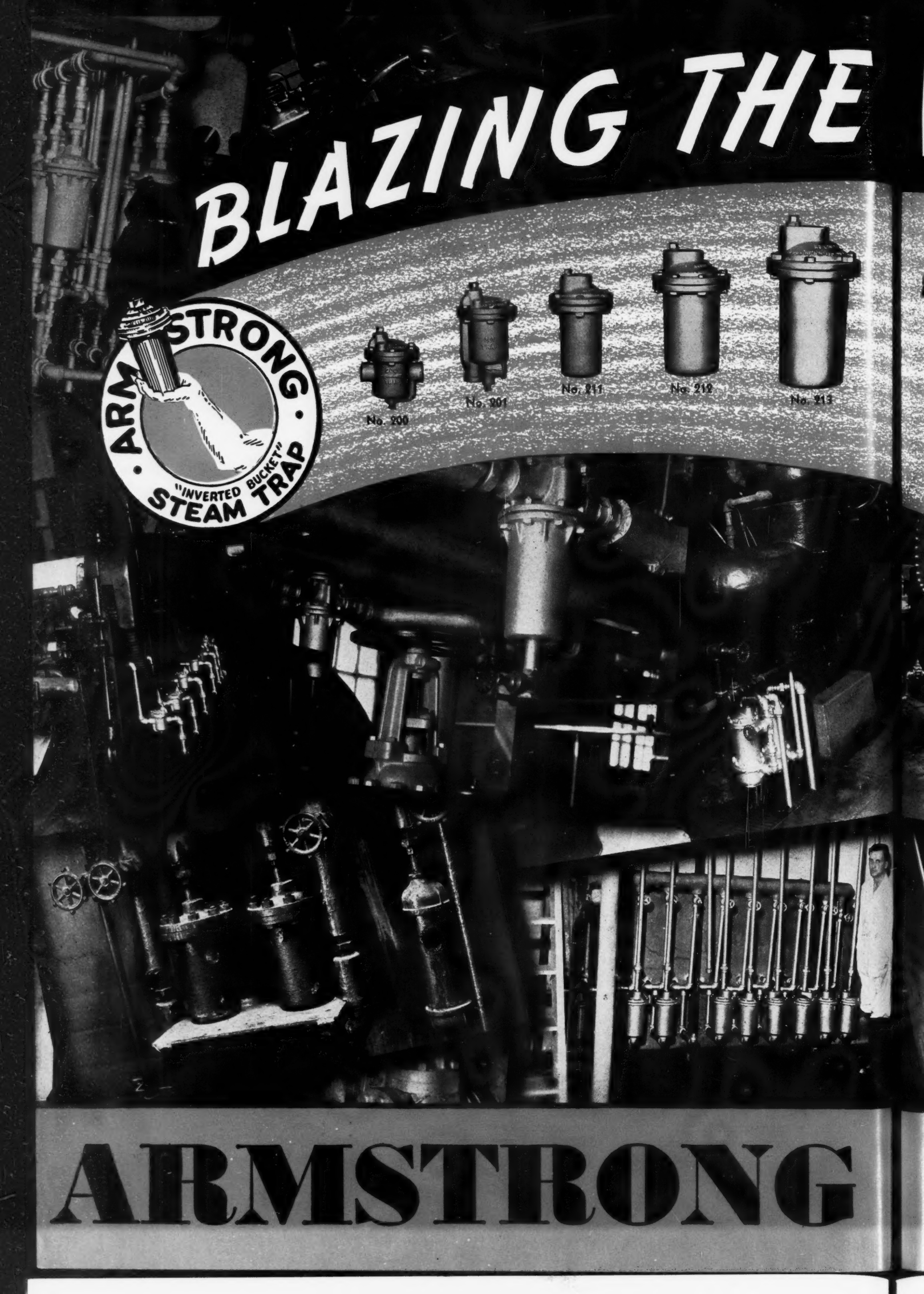
The long control panel in the refrigeration room, Fig. 2, carries the Cutler-Hammer controls for the compressor motors, main chilled-water and condenser-water pump motors, and cooling-tower fan motors. A push-button remote-control panel in this room operates all motors. Flow of chilled water and condenser water is measured by Brown flowmeters.

Machinery rooms at strategic points contain fans, filters, and spray-type dehumidifiers. Automatic controls regulate the mixture of outside air and return air passed through the dehumidifiers with a fixed minimum quantity of outside air. Automatic controls also regulate the amount of recirculated air bypassed around the dehumidifier and mixed with the conditioned air from the dehumidifier so that an even temperature is maintained within the conditioned space.

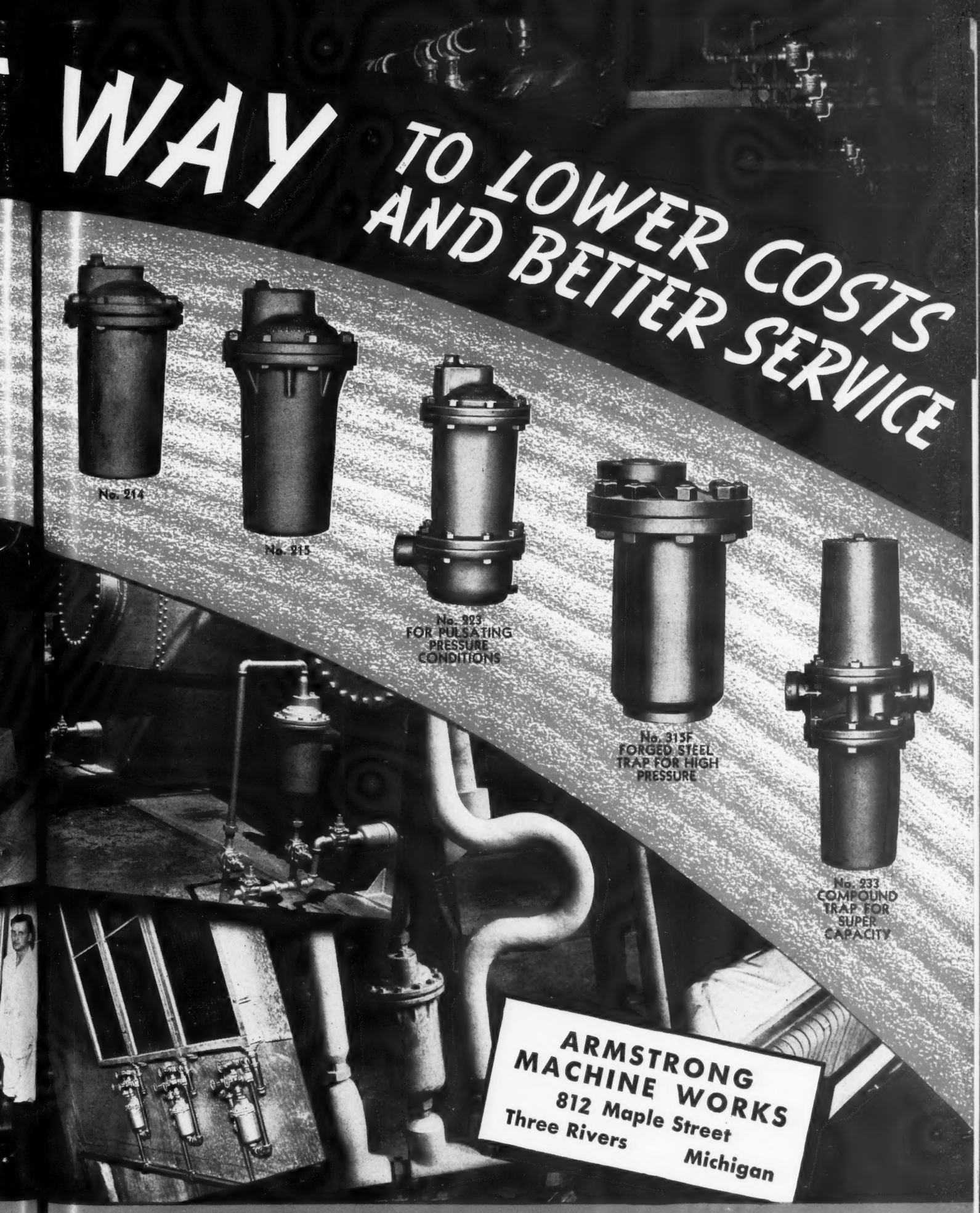
Automatic temperature and humidity controls are Powers Regulator. The 16 Buffalo Forge fans used range in capacity from 3600 to 85,000 cfm and the total fan capacity is over 500,000 cfm. The seven Carrier dehumidifiers have capacities from 14,000 to 85,000 cfm. Fans are driven by Westinghouse motors from 1 to 50 hp in size. Drives between fans and motors are Allis-Chalmers Texrope, with the exception of one Rockwood-base flat-belt drive. Total connected horsepower of the system is 2295.

Ductwork was furred in to conform to the decorative scheme, Fig. 3, and the duct system laid out to conform to the architectural motif of the buildings.

In order to have the system in operation by the cooling season, it was necessary to complete substantially the installation in three months, which was record time considering that a large part of the work could be performed only at night and that only a very small part of the existing ventilation ducts could be used. Carrier Corporation made the installation. Charles S Leopold of Philadelphia was the consulting engineer.


BLAZING THE
ARMSTRONG
"INVERTED BUCKET"
STEAM TRAP
No. 200
No. 201
No. 211
No. 212
No. 213
ARMSTRONG

WAY TO LOWER COSTS AND BETTER SERVICE



ARMSTRONG MACHINE WORKS
812 Maple Street
Three Rivers Michigan

Steam Traps

Number 65

FIELD TEST CODE FOR DIESEL ENGINES*

FOLLOW this test procedure promptly after installation under supervision of the engine-builder's engineers, who shall have opportunity to make adjustments on engine and auxiliaries before test. The object is primarily determination of output and fuel consumption, secondarily collection of other operating data.

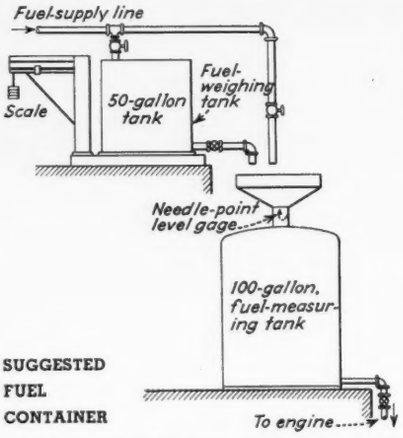
To meet the primary object, these measurements must be made: (1) Gross kwhr output delivered to switchboard, (2) net kwhr output (gross output minus that part consumed by essential auxiliaries), (3) weight of fuel consumed, (4) speed in rpm.

To attain the secondary object, these measurements must be made: (1) pressures: barometric (28.25 in. Hg min), injection air, scavenging air, lubricating oil at pump discharge, jacket-water inlet to oil cooler and to engine, raw water (a) to and (b) from heat exchanger, compression (at stable operating temperature), firing (max.) (2) Temperatures: engine-room (90 F max.), intake air, scavenging air (in crankcase or receiver), exhaust (at cylinder outlets to manifold), lubricating oil (a) to and (b) from oil cooler and (c) to and (d) from engine, piston-cooling fluid (a) to pistons and (b) from each piston, jacket water (a) to and (b) from engine and (c) to and (d) from heat exchanger, raw water (a) to and (b) from heat exchanger. (3) Other measurements: physical properties of fuel oil conforming to the engine-builder's specifications shall be determined by standard ASTM test methods.

Instruments and Apparatus—These are required to make the secondary tests: (a) a container from which the engine draws its fuel and (b) a weighing device (see the sketch), (c) accurate scales, (d) pressure gages as indicated, plus (e) diesel-engine indicator for "pull" cards indicating compression and firing pressures, (f) thermometers and pyrometers, (g) tachometer, (h) revolution counter (i) calibrated electrical instruments for unit gross kwhr output and essential-auxiliary input, (j) water rheostat, or other steady load of accurately determinable power factor.

Preparations—(a) Secure proper condition and function of engine. (b) Record data called for in test record form as far as available. (c) Check and install instruments and apparatus. (d) Assure uninterrupted jacket-water supply. (e) Assure sufficient fuel supply, so that one grade will last throughout test. Fuel should fulfill builder's specifications. (f) Assure sufficient lubricating-oil supply, of a grade to meet engine-builder's specifications. (g) Record such adjustments and settings as have effect on engine performance, i. e., valve timing, injection timing, valve life and clearances.

Schedule of Tests—(a) Make these tests under steady load: 1 hour at ½ load, 1 hour at ¾ load, 2 hours at full load. (b) Before each test bring the engine to stable state under test conditions, indicated by readings made a part of the record. (c) During test, take and record readings at 15-min. intervals.



SUGGESTED FUEL CONTAINER

Into the container neck projects a needle pointing upward. When this point is about to break the surface of the fuel column, it indicates an exact level. Before beginning the test, fill lower tank slightly above needle point and stop fuel supply. As fuel level passes needle point, note time and begin test. Supply fuel in accurately measured quantities from upper tank, and adjust flow to maintain fuel level near needle point. Just before end of test, adjust fuel flow to maintain exact level at needle point.

(d) Read indicating instruments at least twice for each period. Read recording instruments and fuel measurements at beginning and end of each period. (e) Collect recoverable uncontaminated fuel leakage for each test period. (f) Consider a test for 10% overload, if run, as approximate only, because generator efficiencies for overloads are not given by manufacturers.

Calculation of Results—(a) For calculation of fuel consumption, first credit collected uncontaminated fuel leakage. Then correct for deviation of high heat value from 19,000 Btu per lb. Express the final result in lb of 19,000-Btu (high-heat value) fuel consumed per hr. (b) Read gross kwhr output directly from switchboard instruments. (c) Deduct input to auxiliaries from gross kwhr output to obtain net kwhr output. (d) Calculate shaft or brake hphr output from gross kwhr output after adding losses between engine and switchboard instruments. These are I^2R losses of stator and rotor coils, core losses, stray-load losses, exciter losses, field-rheostat losses, cable losses, bearing friction and windage losses, friction losses in chains or belts.

In standard engine- or weighted-rotor generators with direct-connected, belted or chain-driven exciters, subtract a single figure to cover exciter, cable and field-rheostat losses, bearing friction and windage, none are allowed for in standard AIEE generator efficiencies.

Full load AIEE Generator Efficiency	Deductions		
	Full	¾	½
94.7 to 96.1	1.75	2.3	3.2
93.4 to 94.6	2.0	2.5	3.4
92.3 to 93.3	2.3	3.0	4.2
91.3 to 92.2	2.6	3.5	4.75
90.3 to 91.2	2.75	3.7	5.0
89.4 to 90.2	3.1	4.1	5.5
88.5 to 89.3	3.4	4.5	6.1
87.6 to 88.4	3.6	4.8	6.5
86.7 to 87.5	3.8	5.1	7.0

If excitation is furnished from outside, these corrections do not apply; there use corrections based on data from the generator builder and agreed upon before test.

Maintain power factor at or above that for which efficiencies are specified throughout all tests.

Tabulation of Results—Use this form:

General Information:

Date of test	Builder
Location	Test conducted by
Owner	Object of test

Description, Dimension, etc.:

1. 2- or 4-cycle engine, single- or double-acting; type of scavenging; cross-head, trunk piston or opposed-piston, wet or dry pistons; oil- or water-cooled pistons; mechanical or air injection; type of combustion chamber; number of cylinders.
2. Class of service.
3. Auxiliaries attached: fuel-supply pump, lubricating-oil pumps, water-circulating pumps, scavenging pumps, air compressors, radiator fans, oil coolers, fuel heaters (all with details of type, capacity, maker's name, etc.).
4. Auxiliaries, independent or separately driven (with details of type, capacity, power, maker's name, etc.).
5. Rated brake horsepower of engine.
6. Rated speed of engine.
7. Make, type and kva rating of generator.
8. Make, type and rating of exciter.
9. Kw rating of generator, corresponding to 100% rated engine capacity.
10. Grade of fuel used for test.
11. Make and type of governor.
12. Number, diameter and stroke of working cylinders.
13. Altitude of installation.

Test Data and Results:

1. Pressures; list on separate lines readings of barometric, injection air, scavenging air, lubricating oil at pump discharge, jacket-water inlet (a) to oil cooler and (b) to engine, raw water (a) to and (b) from heat exchanger.
2. Temperatures: (On separate lines) engine, room, intake air, scavenging air (in crankcase or receiver), exhaust at cylinder outlets to manifold, lubricating oil (a) to and (b) from oil cooler and (c) to and (d) from engine, piston-cooling fluid (a) to and (b) from each piston, jacket water (a) to and (b) from heat exchanger, raw water (a) to and (b) from heat exchanger.
3. Fuel Properties.
4. Total Fuel Quantities: (on separate lines) gross fuel, lb; recovered fuel, lb; net fuel, lb.
5. Hourly Fuel Quantities: net fuel, lb. per hr; net fuel, corrected to 19,000 Btu per lb high heat value, lb per hr.
6. Speed: rpm.
7. Electrical Data: volts, amperes, power factor, gross kw output, std generator efficiencies, corrected generator efficiencies, deductible kw input to auxiliaries, net kw output.
8. Power: brake, or shaft output of engine, kw; brake, or shaft output of engine, b hp
9. Economy Results, expressed in fact corrected to specified high-heat value of 19,000 Btu per lb; lb per kwhr (gross kwhr output), lb per kwhr (net kwhr output, auxiliaries deducted), lb per shaft (or brake) hphr.

Fuel Specifications for Field Tests—Pipe scale in new lines and foreign matter in new fuel tanks may force special cleaning during test. Request engine-builder's recommendations, then supply necessary equipment. Fuel oil must be in accordance with engine-builder's specification for the particular engine.

* *Condensed, with permission, from "Standard Practices" of the Diesel Engine Mfrs Assn, 2 W 45th St, New York, N. Y.* (They also include tests for governing.)

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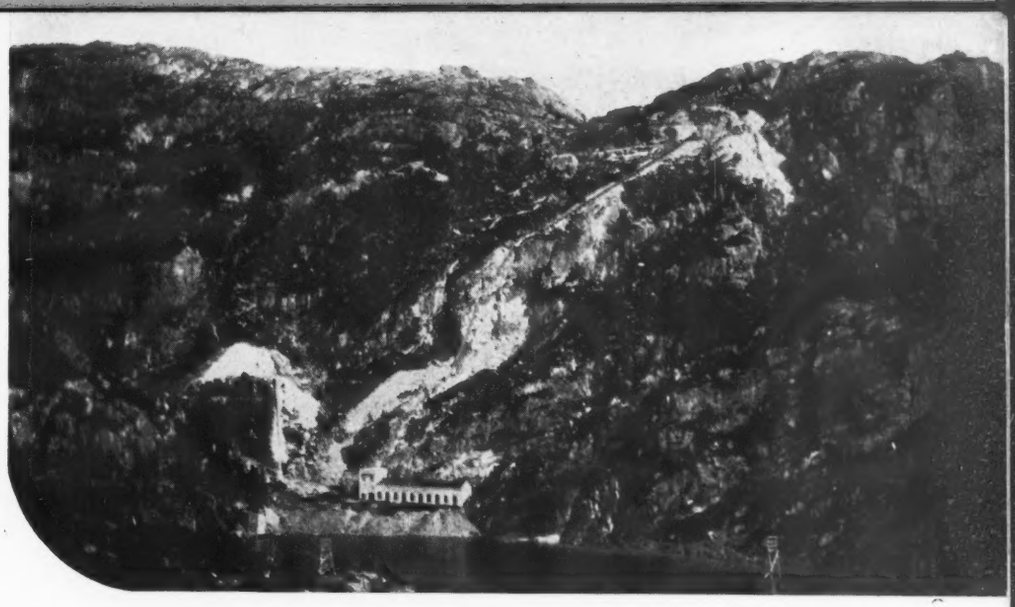

Fig. 1—It took two cable inclines and a narrow-gage railway to get equipment to this hydro plant

AN ERECTOR REMEMBERS

N L Rea, construction engineer for General Electric, recalls the installation of a hydro plant at which eight men had to use six languages to understand one another. But language difficulties were trivial . . .

PEOPLE VERSED in the ways and wiles of erecting men have a high regard for their fluency and range of expression. Even the best of men, though, cannot keep up language studies when they have to shift countries over night. Yet, the job must go on in spite of language handicaps, and one needs must do his best with what languages are available, plus unlimited sketch paper and hand waving.

Perhaps an actual situation will best illustrate the maneuvering often necessary. The scene is a meeting to plan and coordinate assembly and erection of a large hydro plant.

Characters are: chief engineer (French with no other language), assistant engineer (French with some Spanish), contractor (Swedish and Norwegian), operating engineer (Norwegian only), waterwheel erector (German only), chief erector (English, Swedish and a very little Norwegian), assistant erector (English and German), another erector (from Texas, with some border Spanish).

We shall assume the waterwheel erector wants to know when water will be available to start the unit and when the generators and switchboards will be ready. He asks the question in German. The assistant erector puts it into English. After it is translated into Swedish by the chief erector, the contractor puts it in Norwegian for the operating engineer. The Texan translates into Spanish and the assistant chief engineer puts the question into French for the benefit of the chief. Then the discussion starts.

Grammar and the proper verbs, adjectives, prefixes, etc, are soon forgotten or perhaps are unknown, for construction languages are far from classical, and phrases or expressions good in Old Mexico may mean something not so polite in Spain.

And there are times when other difficulties make language troubles seem trivial. In the case above, the power house, back in the mountains, was reached by two cable inclines and an intermediate section of narrow-gage railway, Fig. 1. So apparatus was taken apart for ease in handling. Stator frames were shipped in sections without laminations or windings.

When laminations were unpacked, they were found soaked from long exposure, so had to be cleaned and dried. Here again, local facilities decided the best method. A long rectangular pan, made from sheet iron and filled with sawdust, was mounted on a temporary

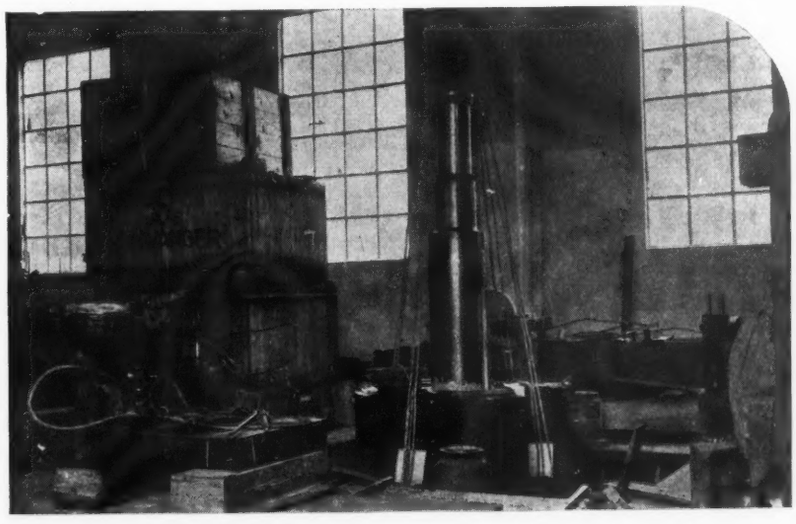

Fig. 2—The first section of one field lowered into place, with the strongback (left foreground) and hydraulic jacks standing ready

stove and kept hot by a slow fire. Several men stood alongside this pan and passed the laminations along through the hot sawdust from one to the next, scrubbing them thoroughly. This did a quick and thorough job of cleaning and drying. Cores were assembled and wound by local labor trained and supervised by the erecting engineers.

Because of the high speed, 750 rpm, the generator fields were very special and there was a flywheel in separate bearings to give the necessary WR^2 for stability. Both flywheel and revolving field were made with extra-large shrink fits to take care of bore stretch at normal operating speed and at overspeeds.

The question of putting these parts on their respective shafts was overlooked by the power company until after parts were shipped. So plans were made to heat the parts enough in an electric oven. Then for fear they might hang up when partway home on their fits, a pressing rig was designed. This consisted of three 150-ton hydraulic jacks provided with an independent pump and manifold and large steel plate for a strongback with six 1½-in. nickel-steel cap bolts. The erecting engineers took with them the drills and taps for putting holes in the ends of the shafts to attach the strongback.

The scheme was to set the shaft on end with the bolt holes uppermost and block it securely, then lower the heated part over the shaft. If it dropped home, well and good. If not, the plate, or strongback, would be bolted quickly to the upper end of the shaft, the jacks placed on top of the piece equally spaced and close to the shaft and hardwood blocks placed between the top

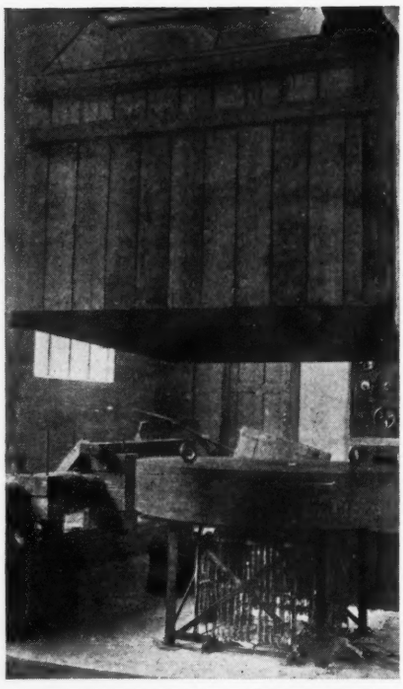

Fig. 3—A flywheel in place over the heaters, with the oven cover (an old box lined with sheet steel) above

of the jacks and the strongback. Blocks were cut and fitted, jacks and pumps connected, and the plate, with special bolts, set where it could be picked up and placed quickly, Fig. 2. Fortunately all parts went together without trouble, so the jacking equipment was not used. The first shaft was drilled and tapped for six bolts, then, when the parts went together so nicely, only three holes were drilled in the rest of the shafts.

The shafts were upended in one generator pit and securely blocked in position. Blocking was provided with stops to locate the flywheel or first section of the revolving field as they were lowered over the shaft.

General arrangement of the oven, heater and a flywheel in place is shown in Fig. 3. This heater was made in two sections, or, rather, two separate heaters, each connected delta. 2600 turns of 0.080 galvanized iron wire was wound on a mandrel of ½-in. pipe and the resulting coil wound bobbin-fashion on a framework of ¾-in. pipe carrying porcelain knobs.

The first piece was supported over wooden posts entirely covered by sheet iron, but the wood was so badly carbonized that it was replaced with the steel framework shown in the picture. The oven cover was an inverted box made from packing-case lumber and lined with sheet iron on battens. This cover had a hatch in the top so expansion of the bore could be checked as heating progressed.

Maximum expansion was reached within 30 hours, although heating was continued longer to make sure of equal heat distribution. There was ample time because other parts of the installation were behind the generator schedule.

If speed had been necessary, a piece could have been heated and installed on the shaft every 24 hours. In view of later experience, the heaters were arranged with baffles to prevent direct radiation to the piece being heated, for fear of distortion or setting up internal strains in the metal. Heat should be taken to the metal by air circulation arranged for uniform and even heating of all parts.

Operators Go To School

Should a special effort be made to explain the workings of new equipment to operating personnel? Here is one case experience

By Richard L Anthony* PROFESSOR OF MECHANICAL ENGINEERING, BUCKNELL UNIVERSITY

THERE IS USUALLY a period of suspense just after new equipment is placed in operation, lasting until the station force has become thoroughly at home with it and all its kinks have been ironed out. If, in addition to being new, the equipment is much unlike that already installed in the station, the problem of training the personnel becomes serious.

Such a problem has been met successfully at the United Illuminating Co's Steel Point Station in Bridgeport, Conn. The first section of this station, described in *Power*, Feb 12, 1924, consisted of three 10,000-kw turbine generators with 12 boilers operating at 225 lb. It was extended from time to time, until in 1935 it contained 7 turbine-generators totalling 80,000 kw and 20 stoker-fired boilers. Steam conditions remained constant at about 225 lb and 500 F. Auxiliaries were almost wholly steam driven, a good exhaust-steam balance being obtained by dual-drive exciters. Combustion control had been applied to a few of the boilers.

A study made in 1935 showed the installation of a superposed high-pressure section justified. This unit is now in operation and consists in the main of two 100,000-lb-per-hr boilers and a 5000-kw non-condensing turbine-generator set. The topping turbine receives steam at 625 lb, 825 F and exhausts to the old main steam header at about 215

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lb, 620 F. The new boilers are fired by pulverized coal and have fully automatic combustion control. All new auxiliaries have electric drive. Feedwater is heated and deaerated at 205 lb.

Before the high-pressure section was placed in regular operation, the men responsible for it were made thoroughly familiar with the equipment. The situation was helped somewhat by hiring three new men who had had experience with pulverized coal, but it was still considered advisable to instruct all the men, if possible, in these matters:

(1) Principles and purposes of superposition, (2) Principles of pulverized coal firing, (3) Piping and electrical systems, (4) Boilers and fuel-burning equipment, (5) Fans and vane control, (6) Combustion control, (7) Deaerating heater, (8) Boiler-feed pumps, (9) Fly-ash precipitators, (10) Ash-handling system, (11) Turbine-generator and control, and (12) Feedwater treatment.

Four Projects

Fortunately, all concerned recognized the importance of an adequate period of training and the consulting engineers, Westcott & Mapes, Inc, of New Haven, Conn, had no difficulty in securing the cooperation of the owner, the operating force and the manufacturers of the equipment.

The instruction was provided by four separate, but inter-related projects, namely, visits to other stations, manufacturers' instructions, a special operating instruction book and a school.

A few, particularly concerned with boiler-room operation, were first sent to visit stations with similar boilers and coal-burning equipment. Arranged by the boiler manufacturer, each trip lasted several days so that the equipment could be observed under all conditions of operation.

The manufacturers of equipment, accustomed to furnishing instructions to purchasers, were requested to make them unusually complete. This request produced a variety of results, all impressive in appearance, but ranging from a set of catalogue bulletins and parts lists to an excellent and specially-written illustrated treatise applying specifically to equipment furnished.

An operating instruction book of about 160 pages with 12 figures and diagrams was written. The book attempts to serve (a) as a record of the equipment installed, (b) as a record of the contents of the manufacturers' instructions, (c) as a manual of instruction for the piping and electrical systems, (d) as a presentation of the relationships among the several kinds of equipment and (e) as a summary of operating instructions for all of the new equipment.

The scope of the operating instruction book prepared by the consulting engineers is shown by the following annotated table of contents.

Part 1, *Introduction.* Purpose of new equipment, brief description, list of innovations involved, list of manufacturers' instructions, purpose of this instruction book.

Part 2, *Equipment.* List of all equipment except certain electrical apparatus, with size, type, capacity, design conditions and descriptions of each item.

Part 3, *Boilers and Fans.* Comments on manufacturers' instructions, detailed instructions for regular starting up, regular shutdown, loss of ignition, emergency shutdown, forced shutdown and fires in coal system.

Part 4, *Automatic Control.* References to and comments on manufacturers' instructions, supplementary instructions, description and purpose of various regulators, valves, relays, etc, control of parallel operation of old and new parts of station, principles of flow measurement and control.

Part 5, *Feedwater System.* References to manufacturers' instructions, description of feedwater system, detailed instructions for operating deaerating heater and boiler-feed pumps.

Part 6, *Feedwater Treatment.* Importance, conditions to be controlled, method of treatment, equipment, chemicals, analysis and testing, periodic reports.

Part 7, *Piping System.* Diagrams of system, tracing of various flows by references to diagrams, discussions of desuperheaters, pressure - reducing valves, relief valves and continuous-blowdown system.

Part 8, *Ash-Handling System.* References to manufacturer's instructions, principle of operation, piping connections, detailed instructions for starting and stopping.

Part 9, *Electric Precipitators.* Detailed list and brief abstract of instructions furnished by manufacturer.

Part 10, *Turbine-Generator.* Description of unit and auxiliary equipment, special features, list of manufacturer's instructions and comments thereon.

Part 11, *Instruments.* Description of each instrument panel, purposes for which instruments are provided, general statement of principles involved.

Part 12, *Electrical System.* Classified list of equipment, comments on special features, wiring diagrams.

The operating instruction book was necessarily written before the new equipment had been placed in service, and in fact before all the manufacturers' instructions had been received. It was realized that certain conditions could be accurately determined only after the station had been running for a time, consequently it is planned to revise this book as soon as sufficient experience has been accumulated from plant operation.

The basic plan of the school was to present a lecture lasting an hour or a little longer, followed by discussion and questions and finally by adjournment to the equipment in question for further study at first hand.

The first four lectures were given by members of the firm of consulting engineers, while the remaining lectures were handled by especially selected representatives of the manufacturers concerned. At least a half day was assigned to each topic, but several were of sufficient complexity to require both morning and afternoon period, so that the entire course included nineteen sessions.

It is not possible to speak too highly of the degree of cooperation which made this course a success. An invitation to be present was extended to all in the station who could attend; the resulting average attendance of 20 to 30 men included not only the foremen and chiefs, but some whose interest in the new equipment might have been thought small. The manufacturers selected their most able engineers. Special lantern slides were made, motion pictures were presented, and in one or two cases is was possible to show working models in the lecture room.

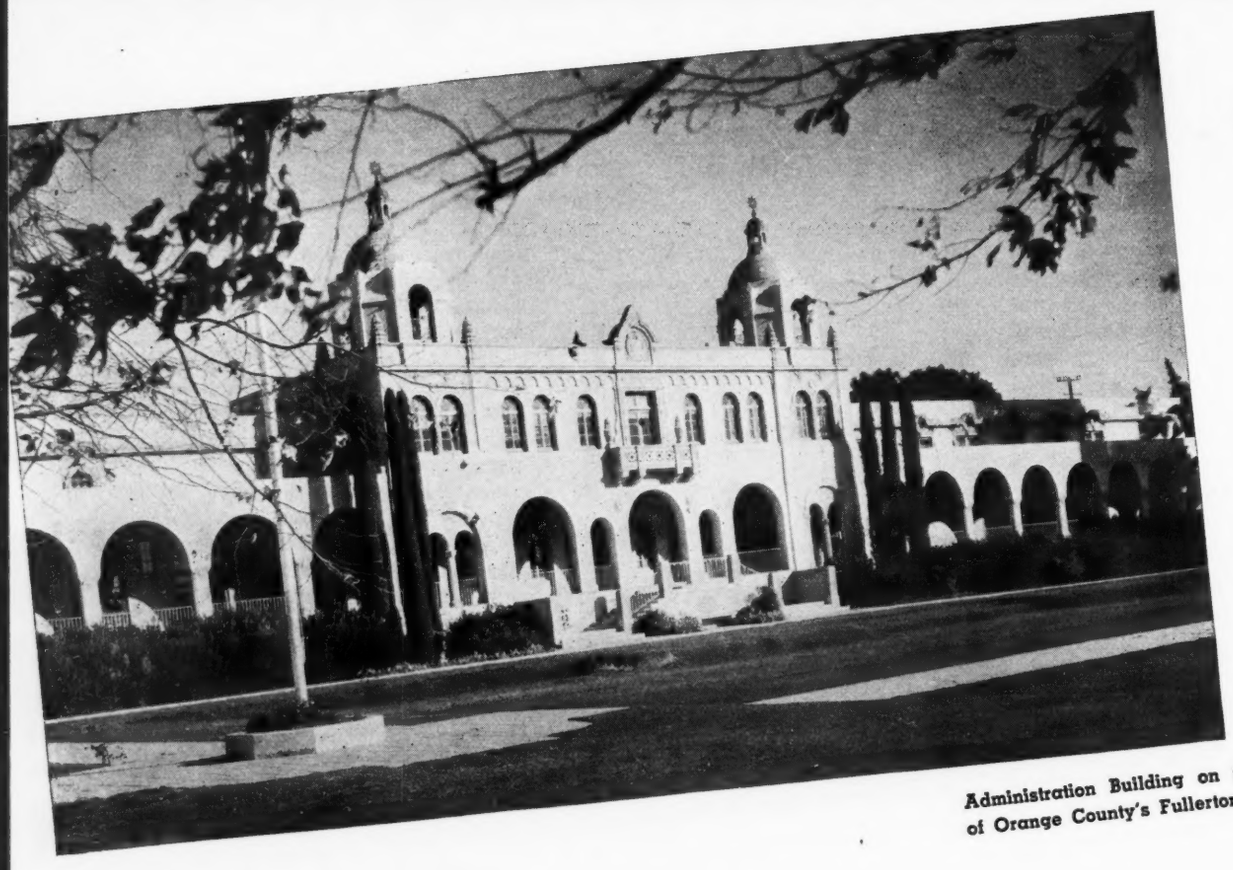
Informal Lectures

The lectures were delivered informally, of course, with interruptions for discussion. The questions and comments of the station force were very much to the point and drew out certain information which might have remained hidden. The consulting engineers found some features of their design questioned by the operators and profited by what they heard.

It is likely that certain byproducts of the course will be important: each man who attended obtained a better knowledge of the station as a whole and perhaps saw more clearly his part in the general teamwork; operators, executives, engineers and manufacturers, four groups who often know too little of one another's difficulties, had an opportunity to discuss common problems together; certain suggestions for further study have been made. The response of the men in the station was far beyond expectation.

In conclusion, a course of instruction, such as that described, requires much effort on the part of its organizers. It may be thought of by some as outside the scope of the consulting engineers' work, but in this instance, at least, our experience has shown the experiment very much worth while.

Smartly-



Administration Building on the 40-acre campus of Orange County's Fullerton Union High School

"WE'LL MAKE A SURVEY" is a common answer when embarrassing questions are raised, and all too often it's just that—an answer. Out at Fullerton Union High School, when the question of continuing private generation or of going to purchased power came up, a survey was made. It was a real, thoroughgoing study, and proved with tests and figtures that private generation was saving in the neighborhood of $6600 a year. The story back of the figures is interesting for two reasons: it shows how unthought-of factors affect economic questions of this kind, making results hard to predict, and it demonstrates again that constant attention to operating details, small improvements, and a knowledge of the plant and plant conditions, really pay dividends.

Fullerton Union High School's buildings are scattered over 40 acres of campus in the heart of Orange County, reputed to be the richest county in California, 26 miles from Los Angeles. More than 4000 ft of service tunnels carrying public address, telephone, signal, and light and power lines, as well as steam, vacuum, water, air, gas and sewer mains, connect the buildings with the power plant. Each building has its own central fan system for heating and ventilating, supplemented, in some of the older buildings, by direct radiation.

Steam is generated in two Llewellyn-Heine water-tube boilers, with 1506 sq ft of heating surface in each. Either gas or oil may be fired in combination burners of the low-pressure atmospheric type. The control system is automatic, using a Mason regulator to operate dampers and a long drive shaft across the boiler fronts, to which is connected the Fisher gas valve, the draft shutters, and the Nemec combination steam-and-oil valve. Boilers are now operated on natural gas, and efficiencies of close to 80% have been attained at 200% rating. This high efficiency with limited furnace volume (426 cu ft) is the result of close analysis of boiler operation. Flue gas is analyzed at several loads every day to check adjustment of the controls.

Turbining Unnecessary

Normally one boiler is operated until its load exceeds 200% rating, thus it is necessary to operate both boilers only two months of the year. Tests have shown that operation at high rating, with the resulting increase in the rate of circulation, and proper water treatment and blowdown, make it possible to dispense with tube turbining. Now, when a boiler is down for inspection, it is given a thorough washing with a hose and left to stand with hand holes and manholes uncovered. Upon inspection, 48 hours or so later, a protective scale may be seen, curling off the tubes. Measurement has shown it to be never more than 0.010 in. thick. Boilers are now blown down three times daily, at 5:00 A M, 12:00 Noon, 5:00 P M.

Power is generated at 2300 volts, by a 200-kva, 3-phase, 60-cycle General Electric generator direct-connected to a McEwen tandem-compound engine. The exciter is belt-driven and has a GE Tirrell voltage regulator. From the main switchboard, power is distributed to seven banks of transformers under groups of buildings.

The engine is more than 25 years old, and was purchased second-hand in 1926. It is 14x23x18 in., and is rated 250 hp at 214 rpm and 150 lb. Since the engine was installed, load has grown as new buildings have been erected. With a slim plant budget, it was impossible to add more generating capacity. To get the most out of the existing equipment, boiler pressure was raised to 185 lb, but only after due consideration had been given to safety, and with the consent of the insurance company. The engine now delivers an average of 290 hp for the 9-hr daily run, with peaks up to 340 hp.

Pulsating voltage, that bugaboo of generation with a single-cylinder, direct-connected engine, has been reduced to the point where there is now no perceptible fluctuation in light intensity. Both slide valves of the engine are on a common rod, controlled by a single eccentric on the inertia arm of the governor. This arrangement hampers fine valve adjustments, but in spite of this difficulty, critical adjustments have been made and have contributed to reducing the voltage pulsation. Friction in the original bearings caused the transmission of undesirable motion to the eccentric pin on the inertia arm. To overcome this, the inertia arm was fitted with Timken tapered bearings, and the

run School Plant

Saves $6600 a Year on Slim Budget

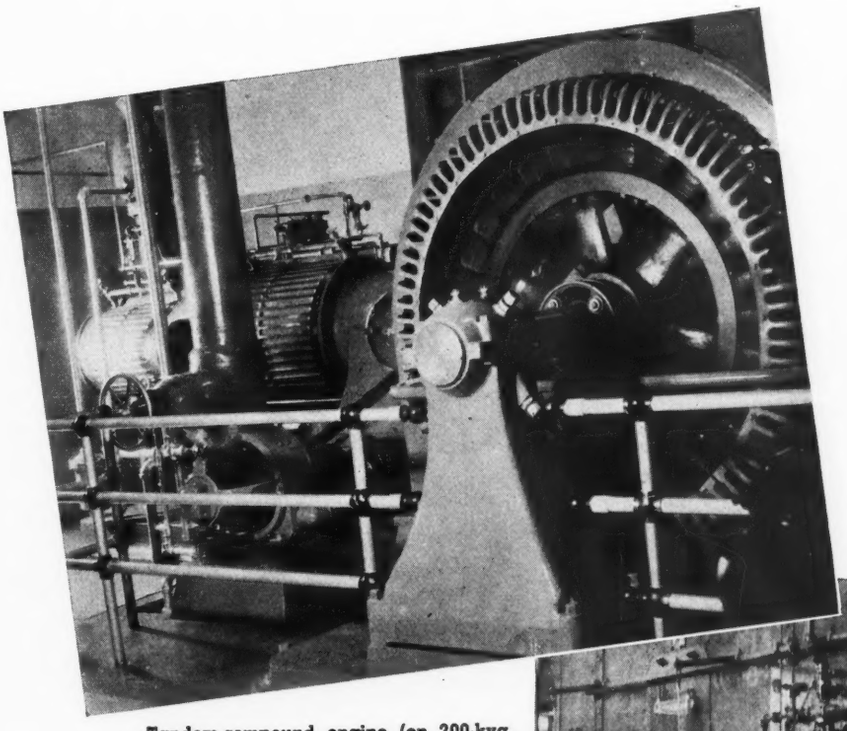
bronze eccentric bearing replaced by a self-aligning double-row ball bearing.

The next point of attack in improving plant operation was power factor, which was low due to highly inductive load. A 2300-volt, 50-kva Westinghouse generator was on hand, so it was natural to rig it up as a rotary condenser. With the exciter field rheostat on the control panel, any desired power factor could be obtained, but in no time at all, out would come the circuit breaker. Some checking and worrying brought under control, and by keeping lay in the difference between the wave characteristics of the condenser and the main generator. Tests showed an excessive flow of current between the two machines, in sympathy with each revolution of the engine, proving the diagnosis right and leaving only the job of correcting the condition. This was done by installing amortisseur windings on the condenser. Pole pieces were removed and eight $\frac{5}{16}$-in. holes were drilled in each, as near the periphery as possible. Lengths of $\frac{5}{16}$-in. copper rod were driven into them and connected with $\frac{1}{4}$ x $\frac{5}{8}$-in. copper strip, silver soldered for strength and high conductivity. Power factor was thus brought under control, and by keeping it at 0.97 leading, it was possible to maintain constant voltage even when a large, across-the-line motor was started, an event that formerly would have caused a severe voltage dip.

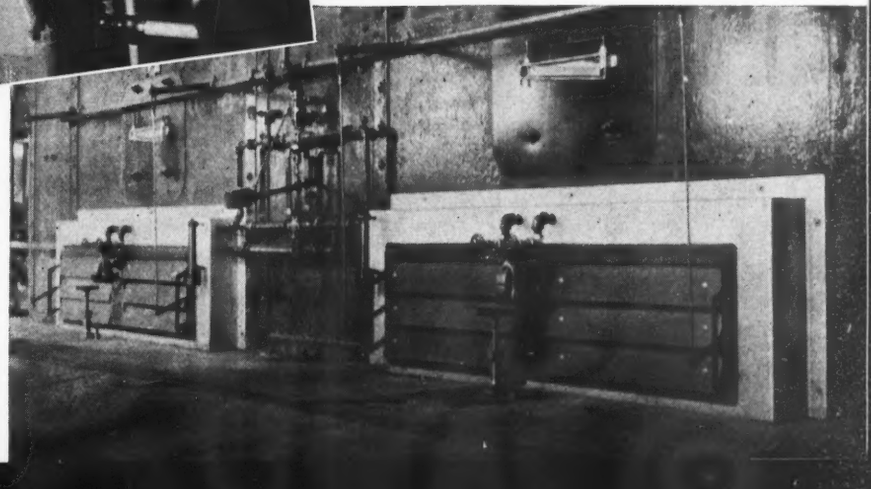
Making the Survey

Early in 1937 the potentially embarrassing question of purchasing power was raised, leading to the making of the survey. It was necessary to know what heat, light and power were costing and how this would compare with the purchase of power plus continued steam generation for heating. This meant a program of testing to determine efficiencies and loads, and analysis of past records of costs. Fortunately, evaporation tests had been run on the boilers only a short time before and it wasn't thought necessary to repeat them, since no changes in conditions had interevened. Gas bills provided data on total fuel costs. Energy consumed by the engine- and boiler-room auxiliaries was measured in a 2-hr test in which condensate was weighed. Quality of throttle steam and exhaust steam was determined by calorimeter measurements, using throttling and separating calorimeters constructed by plant employees. Power output was obtained from recording watthour meter readings, and the log. Disconnecting drip traps on steam mains in the tunnels and weighing the condensate gave a measure of the transmission losses. Heating load was calculated from average recorded air temperatures, and fan outputs from anemometer tests. Results were checked by the conventional heat-loss method, using mean temperatures furnished by the U S Weather Bureau and checked by those in the power-house log. Lights and power loads were studied with a portable load-testing ammeter, at points of distribution, and checked against readings on the recording watthour meter.

So much for the raw material for the comparison. How was it made? First, the cost of steam for heating was figured. Right here occurred one of those quirks which make the results of comparisons so hard to predict in advance. Gas for generating steam for power had cost $0.175 per M cu ft, but gas for heating alone would cost $0.365 per M, an increase of more than 100%. So even though steam consumption would be reduced by shutting down the engine, the total cost would be higher due to the change in the rate schedule for gas fuel. Cost of power was added in at $0.0169, the expected average rate, to get total cost under the proposed plan of operation. This was then compared to the total cost for generating both steam and power (present operation), and was found to exceed it by some $6600 per year. Actually, the cost of steam for heating alone was discovered to be greater than the present total cost for heat and power.



Tandem-compound engine (on 200-kva, 3-phase, 60-cycle, 2300-volt generator)



Combination oil- and gas-burners under 1506-sq ft boilers

Test of

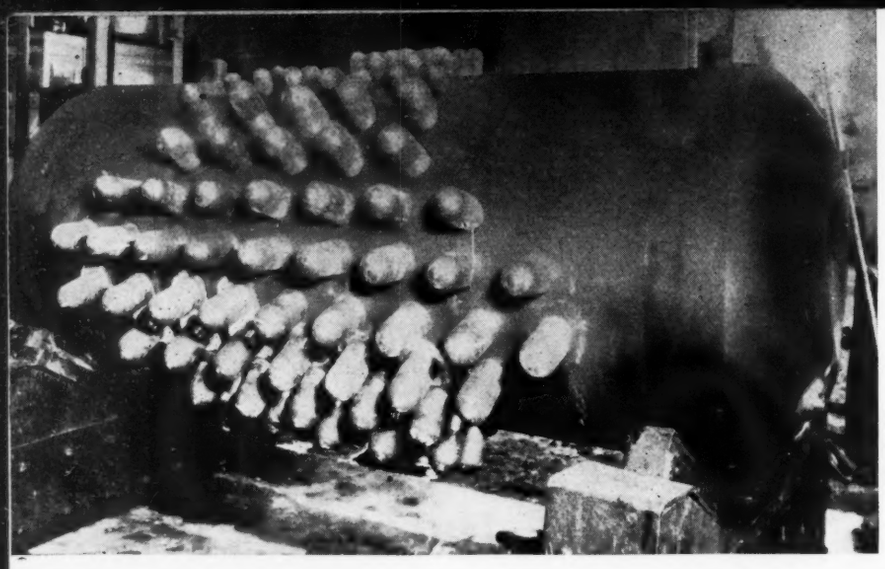


Fig. 1—Test drum with closed-end nipples expanded in holes

ALTHOUGH FOR SEVERAL YEARS the Boiler Code of the ASME has allowed the use of boiler shells with welded seams, it still does not permit boiler shells in which holes for tubes are bored through the weld metal, or bored so that the edge of the hole is at the line of junction of plate metal and weld metal.

With the object of securing some reliable information on the strength of welded drums in which radial tube holes had been bored in the plate, through welds, and at the junction of weld metal and plate metal, a drum constructed for this purpose was tested recently at the works of The Babcock & Wilcox Co, Barberton, Ohio.

Fig. 1 shows the drum ready for test, with tube holes plugged with closed-end nipples expanded into tube holes by rolling. Fig. 2 is a development of the shell, giving the layout of the holes, their sizes, and the location of the welds. Four typical locations of holes through welds, or at the edge of welds, are shown in Fig. 3. By referring to Fig. 2, it will be seen that 17 holes were located as shown by Fig. 3a, 17 as shown by Fig. 3b, one as shown by Fig. 3c, and one as shown by Fig. 3d, a total of 36 holes drilled through welds or at the edge of weld metal. In addition, 171 holes were bored through plate metal.

There were 30 ligaments between the holes drilled through the welds, not counting diagonal ligaments between different sets of holes and between offset lines of holes. In a test drum without holes in the shell, the longitudinal tensile stress set up by any internal pressure is one-half as great as the circumferential stress. Holes in the test drum were spaced closer together in a circumferential direction than in a longitudinal, and the larger the holes in the group, the greater the distance between holes. The spacing was such that under any pressure, the same tensile stress was set up in each of the 30 test ligaments; circumferential and longitudinal ligaments were equally stressed. The inclined ligaments were greater than the test ligaments and were under somewhat less tensile stress. A large number of ligaments in the plate metal were, of course, also subjected to the same tensile stress as the 30 ligaments in the welds. The computation of stress in the ligaments was made by the usual formula for thin cylinders, making due allowances for the metal removed, but no allowances for stress concentration.

To eliminate the possibility of failure in the drum heads, they were made stonger than the standard.

Plate material was purchased under ASTM Specification (tentative) A 150-35T, Grade B. The physical and chemical properties of plate metal and weld metal were determined in the B & W laboratories:

PHYSICAL PROPERTIES—TENSILE TEST

Metal	Yield Point	Tensile Strength	Elongation in 2 in.	Reduction of Area
	lb per sq in.		per cent	
Plate	43,100	72,800	26.5	—
Weld	63,500	78,000	17.0*	31.2
Weld	56,000	73,500	21.0	26.8

* The elongation value of 17% was in all probability due to weld porosity.

A transverse tension specimen having full thickness, and made according to Fig. P-2, ASME Power Boiler Code, with reduced section at the weld, so as to produce fracture in the weld, showed a tensile strength of 78,500 lb per sq in.

PHYSICAL PROPERTIES—BEND TEST OF WELDED SPECIMEN

Thickness of specimen	0.75 in.
Angle of bend for crack	110 deg.
Redius of bend	3 in.
Elongation at weld (outer fibers)	20%

CHEMICAL COMPOSITION

Values given in per cent

	Plate Metal	Weld Metal
Carbon	0.26	0.09
Silicon	0.19	0.04
Manganese	0.84	0.33
Phosphorus	0.019	....
Sulphur	0.031	....
Molybdenum	.....	0.20
Nitrogen	.....	0.031

Chemical and physical properties, and also the amount of porosity as shown by the X-ray test, were purposely made below the standards required by the ASME Code, so that welds made to ASME standard would be better in service than the weld actually under test.

It seemed desirable that the welds should not be of extraordinarily good quality, that they should not indicate unusually low porosity, as shown by radiographs. A special electrode developed with the purpose of making a weld which would barely meet the original requirements for porosity given in the ASME Boiler Code was used in welding the seams. Less porosity is sanctioned by the present standard films and the porosity of the welds was therefore much greater than now sanctioned. Radiographs of the welds show that the circumferential welds were about at the limit of acceptability, as was intended. As the longitudinal seam was welded with the same electrode, the drum welding, on the whole, was probably below average. At the completion of the welding operations, the drum was stress-relieved.

Tests

The test drum was subjected to cycles of hydrostatic pressure, and in each cycle the pressure varied from zero to 580 lb per sq in., setting up a tensile stress of 21,000 lb per sq in., as computed by the formula for thin cylinders. This is 50% greater than the working stress of 14,000 lb per sq in. permissible with a factor of safety of 5, and steel with a tensile stress of 70,000 lb per sq in., assuming a welded-joint efficiency of 100%

The apparatus used alternately admitted water to the test drum and allowed the pressure to be relieved, about 15 cycles of pressure being applied each minute.

The test lasted forty days, and during this period no leakage or fine spray, which would have indicated failure at any part of the test drum, was observed, nor were any signs of leakage or failure observed when the final inspection was made.

While previous experience with fatigue tests of pressure vessels made it seem almost certain that any failure would be a very gradual one, and that the final breaking through of a

* Research professor of Engineering Materials, University of Ill. Professor Moore served as special consulting engineer for The Babcock & Wilcox Co in connection with the tests described here.

Drum Ok's

TUBE HOLES IN WELDS

Repeated-stressing of a welded boiler shell checks effect of holes in plate and welds from report of H F Moore *

crack would not cause a total failure of the shell, precaution was taken to surround the vessel with a heavy net.

The report of the test shows that there were four shutdowns for inspection; after 80,000 cycles of pressure, after 185,000 cycles, after 500,000 cycles, and, finally, after 800,000 cycles.

The most obvious result of the test was the absence of any evidence of cracks in the ligaments of the shell, in the plate metal, in the weld metal, or at the junction between the two.

Results

In certain tests of arc-welded drum shells, reported in the ASME Transactions (Fuel and Steam Power Division), Vol 53, No. 1 (Jan-April, 1931), one of the outstanding results was the evidence obtained of the injurious effect of tapped holes in the shell, especially of a tapped hole in the weld metal.

Two major questions to be answered from the test results are:

(1) Do tube holes with tubes expanded in place by rolling cause disastrous effects similar to those caused by tapped holes?

(2) Do tube holes with tubes expanded in place by rolling cause more damage in weld metal than in plate metal?

The results of the Barberton test seem to indicate that with tube holes having rolled-in tubes, there is less possibility of damage than with a small tapped hole. This is not surprising, when it is remembered that the damage done by a small tapped hole is mainly damage by stress concentration due to the hole and to the cutting of the surface of the metal, and only to a slight degree due to diminution of area of plate or weld metal. On the other hand, the possibility of damage from relatively large tube holes spaced closely together is mainly due to diminution of area of plate or weld metal, and this is taken into account in computing tensile stress in ligaments. The damage to the surface of the plate or weld metal by tapped holes is greater than any damage that could be caused by tube holes with rolled-in tubes. Various experimenters have found that the fatigue strength of steel may be increased by slightly transforming a surface by rolling, whereas it is diminished by a cutting-tool surface. Taps frequently tear the surface of metal, and it is not surprising that a tapped hole should reduce the fatigue strength of the net section of a steel plate more than relatively large closely-spaced tube holes with tubes expanded into the holes.

As no failure occurred in any ligaments of the test drum, either in the plate metal or in the weld metal, a quantitative comparison of the damage done in the two metals could not be made. There was no evidence of any loss of strength in any ligaments, but, of course, a test to destruction would be necessary to give any comparison of damage to plate metal with that to weld metal.

Results of the test seem to offer considerable evidence that there is little to be feared if tube holes are bored in a boiler shell, either through plate metal or weld metal, if the holes are fitted carefully with tubes expanded in place by rolling, and if the computation of ligament stress takes account of the removal of metal.

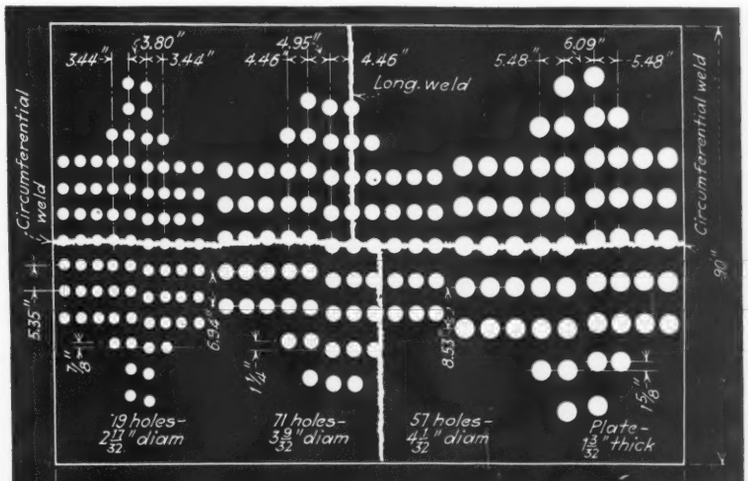


FIG.2

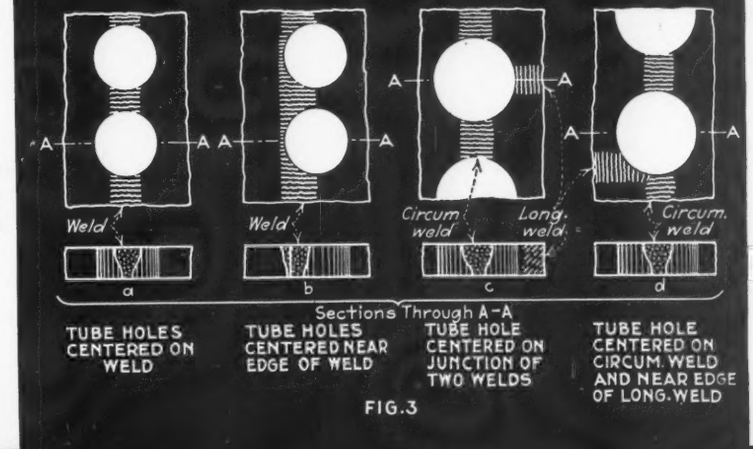
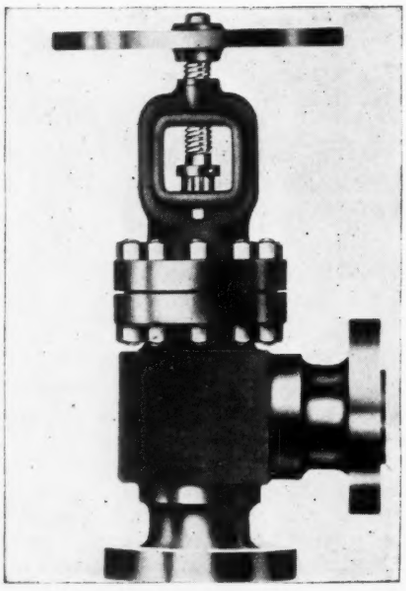


FIG.3

Fig. 2—Development of plate of test drum with holes located. Fig. 3—Location of tube holes with respect to welds

WHAT'S NEW IN PLANT EQUIPMENT



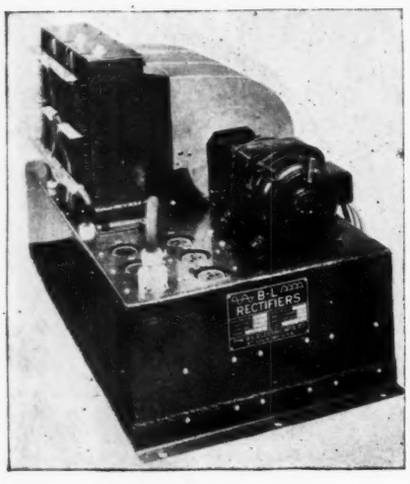
FORGED-STEEL STOP VALVE

MADE from single block of forged steel in sizes from 2½ to 8 in. for pressures up to 2500 lb per sq in., with flanged ends or with ends prepared for any type of welding. Bodies, flanges and bonnets are all hammer forged from chrome-molybdenum steel, all seats are Stellite faced, bolting is of Class C ASTM steel, and trim is of stainless steel. Made in both angle and offset types; latter has pressure drop approaching that of a gate valve. Special internal bypass is provided.

Clees Valve & Engrg Co, 90 West St, New York, N.Y.

HEAVY-DUTY BATTERY CHARGER

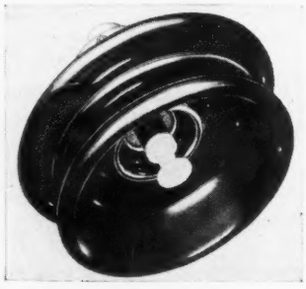
RECTIFIER battery charger may be mounted in any convenient location, or with rubber-tired wheels. Heavy metal base houses transformer with supplies dry, metallic rectifiers. Mounted above transformer, on top of base, is 3-gang centrifugal blower driven by ball-bearing motor. This blower propels air at relatively high velocity through radiating fins of three rectifier stacks. Average charging rate of about 100 amp for lead-acid battery of 16 cells, or nickel-iron battery of 25 cells. Operates on 3-phase 220-volt current.



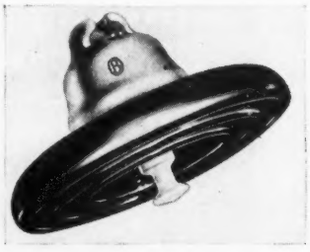
B-L Electric Mfg Co, 19th & Washington Ave, St Louis, Mo.

SUSPENSION INSULATORS

Two rugged suspension insulators, one of petticoat design (shown in illustration) and one with smooth disk, have high impact resistance to minimize breakage. Cap and pin return to normal position after repeated loading. Hardware



has zinc coating alloyed to base metal for corrosion resistance. Both types have 10-in disk and 15,000-lb M&E rating, and either 5- or 5¾-in. spacing. 5-in units have socket cap and ball pin; the other either socket cap or ball pin or clevis cap and pin. Also recently developed is fog- and contamination-proof suspension insulator with inner and outer petticoating. Shell has 10-in diameter and 4-in. droop, allowing liberal clearance between ad-

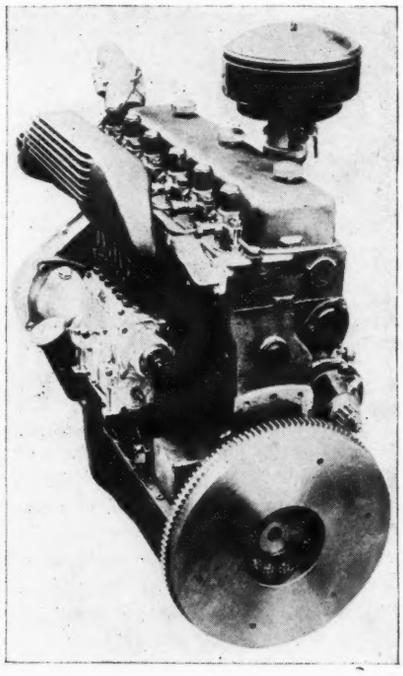


jacent units spaced at 6½ in. This prevents sparking from cap of one insulator to flange immediately above or below it, and also helps to avoid short-circuiting by drip water. Dry flashover value of 105 kv, wet value of 55 kv; dry arcing distance of 9.6 in., wet distance of 4.7 in; and M&E rating of 15,000 lb. Made with socket cap and ball pin or clevis cap and pin.

Ohio Brass Co, Mansfield, Ohio.

LIGHTWEIGHT DIESEL

"PANTHER" 6-cyl diesel is a vertical engine with 3.5-in. bore, 5-in. stroke. Is designed principally for commercial vehicles, and is capable of 4000 rpm un-



governed, though governed engine is held to 2600 rpm and set to give 85 hp. Without flywheel, weight is 580 lb. Two fuel sprays are used, one leading into combustion chamber, other into open cylinder. In addition, fuel is discharged into air stream before it actually reaches combustion chamber. Oil from lubricating pump is carried to main bearings through passageway cast in block. Filtered air from air cleaner drawn through engine maintains a vacuum equal to half a head of water in valve chamber and crankcase.

F Perkins, Ltd, Peterborough, England.

BRINELL INSTRUMENT

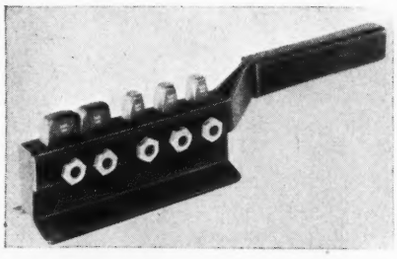
LIGHT-WEIGHT, portable "Telebrineller," for testing Brinell hardness, consists of metal tube supported in soft rubber head, rubber spacing block, tube holding bar of unknown hardness. An anvil in top of rubber head rests directy on bar. Be-

low bar end, impression ball, secured in narrow aperture in base of head, comes in direct contact with metal to be tested. Spacing bar holds specimen in clear area for each test. To make test, instrument is held against specimen and anvil struck a sharp blow with 3- to 5-lb hammer. Diameters of impressions are then measured in 1/10 millimeters by placing microscope over each in turn and reading scale. Brinell hardness is figured by arithmetical formula or slide rule.

Teleweld, Inc, Railway Exchange Bldg, Chicago, Ill.

PIPE MARKER

HOLDER No. 63 holds steel stamp in place while marking steel pipe, bar, cylinders and other round objects. When several stamps are used, unit holds them in alignment. Stamps have



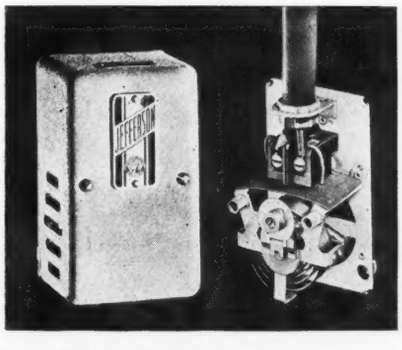
"Safe-Hed" and "Tuf-Face" features, result of special heat treating and quenching. Stamps are grooved on one side and held in place by a turnscrew.

J H Matthews & Co, 3942 Forbes St, Pittsburgh, Pa.

TEMPERATURE CONTROL

TAMPER-PROOF air-switch has control knob and scale plate removed from outside of enclosing case, and range adjustment can be made only by removing case. Absence of usual control knob removes temptation to tamper.

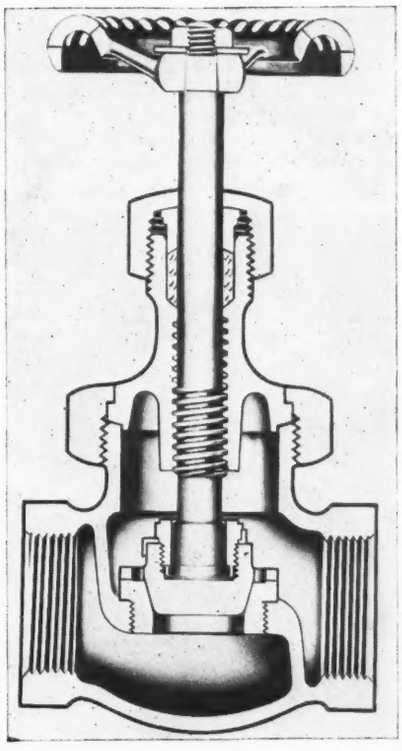
Jefferson Electric Co, Bellwood, Ill.



EYE PROTECTION

"SNOPAKE" reduces excessive glare experienced during winter months in buildings adjacent to open fields where large expanses of snow may be present. Product is a pale-green adhesive liquid that can either be brushed or sprayed on windows. Is applied to inside or outside of window and remains on glass until removed with hot water and stiff bristle brush. Admits over 90% of light, yet reduces it to softly diffused illumination.

Skybryte Co, Cleveland, Ohio.



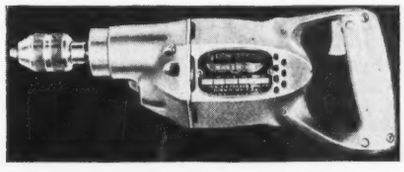
PLUG-DISK VALVES

BRASS globe and angle valves have disk of nickel alloy and body seat ring of heat-treated chromium iron (Exelloy). For 150-lb steam and 300-lb cold water, oil or gas. Stuffing boxes are fitted with a gland, which may be repacked under pressure when wide open. Size range of ⅛ to 3 in. Also recently developed are iron-body valves, made in sizes ¼ to 3-in., with same characteristics and construction. Illustration shows brass globe valve.

Crane Co, 836 S Michigan Ave, Chicago, Ill.

ELECTRIC DRILL

FOR stainless steel, Monel metal, and other hard metals, this ¼-in. low-speed drill has standard spindle of 450 rpm. Powerful universal motor, operating through triple-reduction gear train, pro-



vides ample torque. Armature and spinde are mounted on ball bearings. Has "Portomatic" keyless chuck and patented gear-locking pin to facilitate quick changing of drill bits. Net weight 6¼ lb; over-all length 13 in.

Black & Decker Mfg Co, Towson, Md.

INSULATION FOR UNDERGROUND STEAM LINES

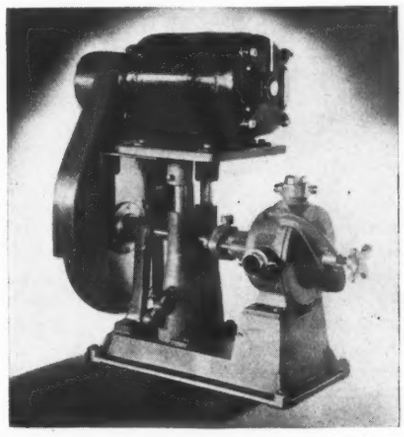
"ADSCO-CORNING filler insulation is composed of long flexible fibers of glass in a soft resilient mass resembling cotton batting, but possessing permanence and chemical characteristics inherent in glass. Has high thermal efficiency, low conductivity rate of 0.33 at 4 lb density, fluffs under vibration, is fireproof, unaffected by water, acids or fumes, and will not corrode pipes in presence of water. Bulletin No. 35-67.

American District Steam Co, North Tonawanda, N.Y.

ROTARY PUMP

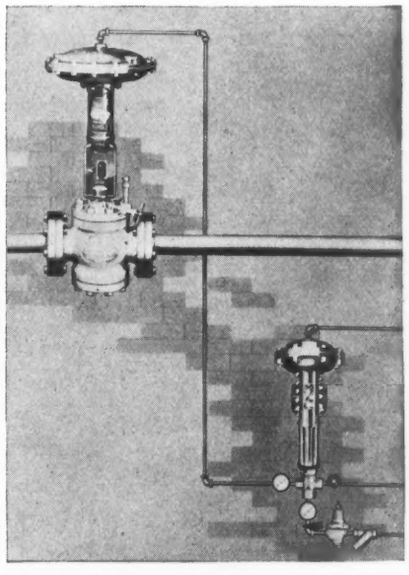
VARIABLE-SPEED, variable capacity rotary pump unit in both standard and sanitary models, the latter for food plants. Turning a small handwheel near the base plate raises or lowers motor base plate, increasing or decreasing pitch of V-belt motor pulley. This in turn changes motor speed and pump capacity. 1800-rpm motor, speed ranges of 200 to 500 rpm are possible. Two single-belt and two double-belt models made.

Viking Pump Co, Cedar Falls, Iowa



PRESSURE CONTROLLER

"SYNCHROMASTER" pressure controller is hydraulic-operated combination of pilot mechanism and diaphragm-actuated control valve. Hydraulic-supply pressure of 20 to 150 lb. Since pilot bleeds only



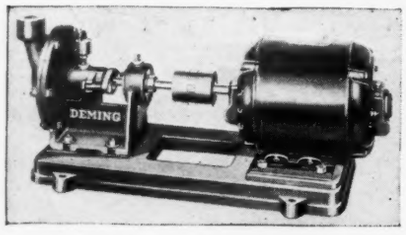
when control-valve-diaphragm pressure is reduced, water consumption is low. Controlled pressure is piped to pilot-valve diaphragm and is balanced by setting of springs. Increases or decreases in

this pressure move piston valve to increase or decrease control-valve-diaphragm pressure, positioning valve plug to maintain required pressure in system. Self-aligning spring buttons, thrust ball bearings, lap-type piston valve of 18-8 stainless steel for pilot. Control valve has 18-8 stainless steel for all parts subject to friction, ball-bearing guides, pressure lubricator.

Mason-Neilan Regulator Co, 1199 *Adams St, Boston, Mass.*

CENTRIFUGAL PUMP

SIDE-SUCTION, single ball-bearing centrifugal pumps made in two sizes: with ½-in. discharge and ¾-in. suction, and with ¾-in. discharge and 1-in. suction. Pumps direct connected to motors suitable to speeds up to 3500 rpm; belt-



driven pumps to 3000 rpm. Non-overloading bronze impeller, stainless-steel shaft, bronze gland and oversize deep-groove ball bearing. Either size pump may be had with direct-connected gasoline engine.

The Deming Co, Salem, Ohio.

WELDING ELECTRODE

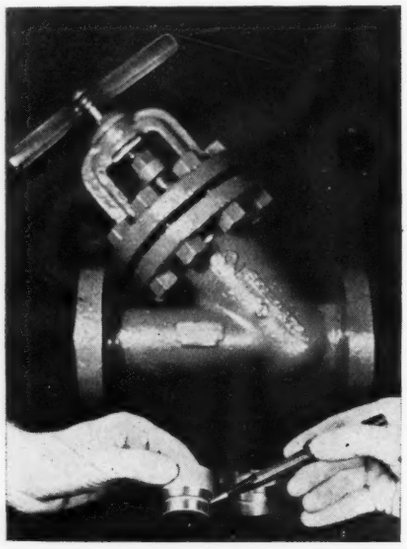
FOR small ac transformer-type arc welder, "Transweld" electrode has heavy extruded coating and stable arc. Tensile strength is 75,000 to 85,000 lb per sq in., yield point 60,000 to 68,000 lb per sq in., and ductility 20 to 30% elongation in 2 in.

Lincoln Electric Co, Cleveland, Ohio.

SPRAY-TYPE AIR CONDITIONER

FS-12000, spray-type air conditioner, for industrial low-temperature applications, handles air volumes up to 16,000 cfm and capacities up to 40 tons of refrigeration. Front, back, or top discharge outlets can be provided and spray-water heaters and air-reheat coils are available. Unit supplements standard line of York conditioners for constant temperature and relative humidity.

York Ice Machinery Corp, York, Pa.



BLOWOFF VALVE

"BLO-DEFLECTOR" protecting lip a feature of this valve. Manufacturer claims that this design principle deflects boiler blow so effectively that valves are almost indestructible. Has steel valve disks hardened to 500 Brinell and renewable Stellited valve-seat rings. Made in both straightway and angle types for pressures up to 1660 lb. Illustration shows protecting lip with 2-in. valve in background.

Hancock Valve Div, Manning, Maxwell & Moore, Inc, Bridgeport, Conn.

CRANE-HOIST CONTROL

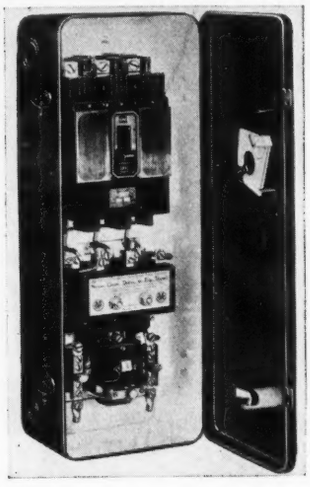
DC crane-hoist control has rocker-bearing contactors and magnetic-time relays, high lowering speeds, good speed regulation, precise spotting of hook, etc. Low power consumption because regenerative braking is obtained for any load requiring 30% or greater braking effort. Dynamic braking available for emergency stops in case of solenoid-brake failure. Automatic control of deceleration by magnetic-time relay provides safe stopping.

General Electric Co, Schenectady, N.Y.

STARTING SWITCH CIRCUIT BREAKERS

COMBINATION starter utilizing circuit breakers has hand-operated disconnect switch and automatic starter. Standard disconnect switch has been replaced by circuit breakers with maximum rating of 30 hp, 220 volts; 50 hp, 440-550 volts. Solenoid automatic starting switch has double break silver-alloy contacts and two thermal overload relays. Circuit breaker is enclosed in molded Bakelite case.

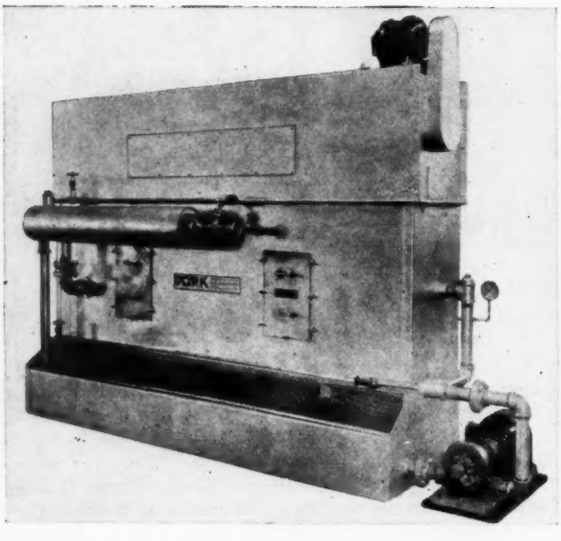
Allen-Bradley Co, 1311 *S First St, Milwaukee, Wis.*

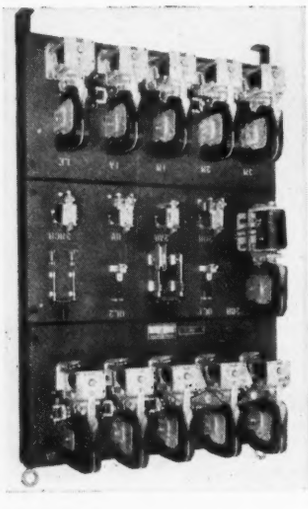


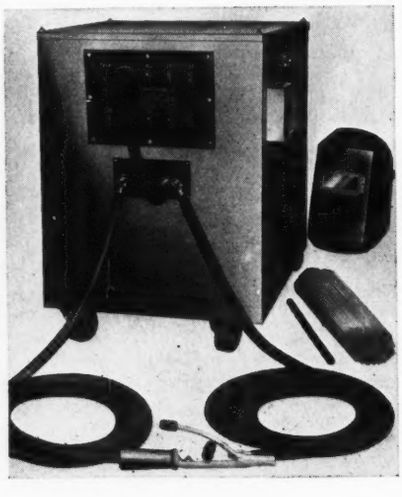
AC WELDER

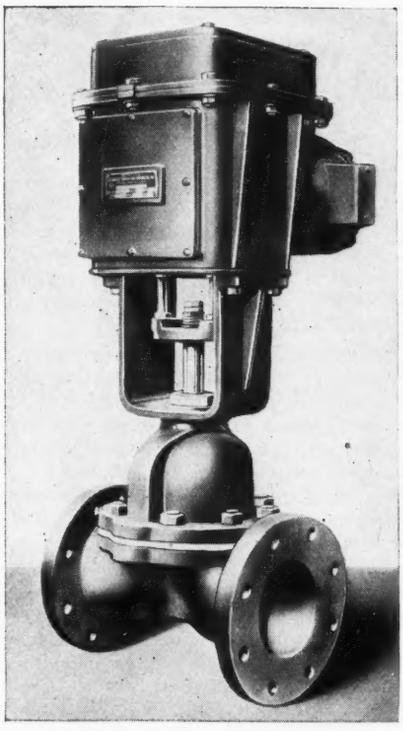
MODEL 250 ac arc welder has plug-in control panel. Output range from 25 to 250 amp in 10 steps. Cast-steel case and ball-bearing swivel casters. Operates on 220- or 440-volt, 50- or 60-cycle current. Forced-draft cooling system and inclosed power terminals. Takes rods up to ¼ in.

Commonwealth Mfg Corp, 4208 Davis Lane, Cincinnati, Ohio.









MOTOR-VALVE MECHANISM

MODEL C unit operates slip-stem valves for higher pressures and larger sizes. Illustration shows mechanism mounted on 4-in., 150-lb valve, and it exerts an opening and closing force on valve stem of 2000 lb with 5 in. per min movement and 2½-in. stroke. Strokes up to 10 in. and speeds of 3 to 10 in. per min are available, with corresponding changes in power. Power release positions valve at definite open and closed points.

Automatic Temperature Control Co, Inc, 34 E Logan St, Phiadelphia, Pa.

EXPLOSION-PROOF SQUIRREL-CAGE MOTOR

TYPE AA ac motors have been tested and approved by Underwriters' Labs for Class 1, Group D hazardous locations. All working parts completely enclosed.

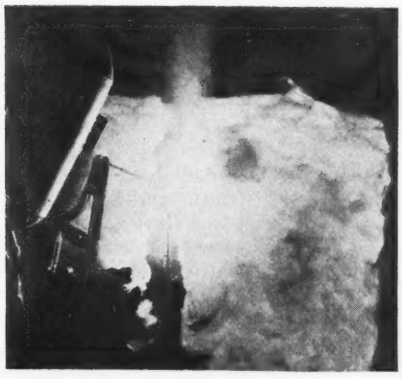
Housing is strong enough to withstand even internal explosion without bursting, loosening joints or permitting flames to escape.

Reliance Electric & Engrg Co, 1088 Ivanhoe Rd, Cleveland, Ohio.

ELECTRIC PIPE PREHEATER

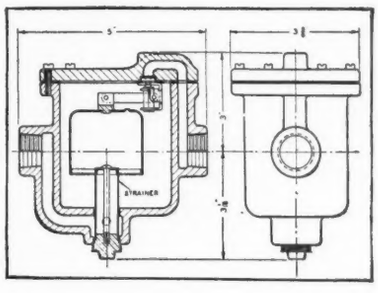
FLEXIBLE electric-preheater for alloy pipes before welding consists of indicating pyrometer, 2-heat switch and an arrangement of adjustable heating elements in a connecting linkage which holds heating elements in direct contact with pipe. A temperature of 600 F is reached in less than ¾ hr on 6-in. carbon-moly pipe. Heaters are arranged for heating a distance of approximately 4 in. on either side of weld to a temperature determined by operator. For single-phase, 220-volt current.

Detroit Electric Furnace Co, 825 W Elizabeth St, Detroit, Mich.



INVERTED-BUCKET TRAP

STRAIGHTWAY trap, addition to inverted-bucket line, made in one size with ⅜ or ½-in. inlet and outlet connections. Connections are arranged on opposite sides of the body on same center line to provide straight-through connection. Work-



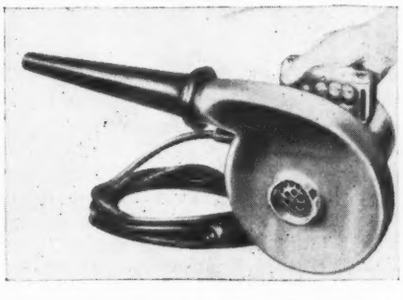
ing mechanism is attached to trap cover so that it can be removed without disturbing pipe connections. Sarco strainer is built into trap, eliminating separate strainer.

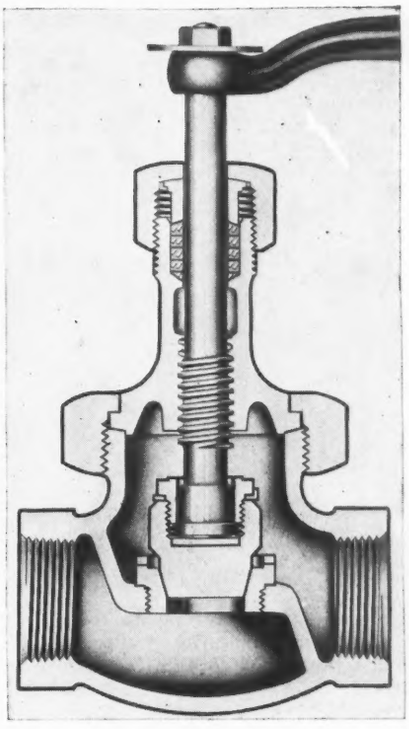
Sarco Co, Inc, 183 Madison Ave, New York, N.Y.

PORTABLE ELECTRIC BLOWER

IMPROVED "Tornado" portable electric blower has new bearing construction to increase motor life. Miners gauze over air-intake holes in housing prevents damage to motor in excessive dirt and dust. For removal of dust and dirt from motors, machinery, etc.

Breuer Electric Mfg Co, 852 Blackhawk St, Chicago, Ill.

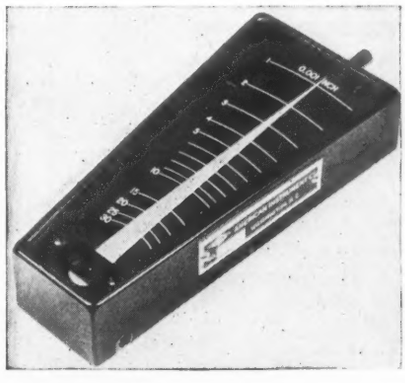




BRASS VALVES FOR 350-LB STEAM

LINE of brass screwed-end globe (in illustration) and check valves for 350-lb steam at 550 F may also be used for non-shock cold water, oil or gas lines up to 1000 lb. Globe valve with union bonnet (except 2-in. which has bolted bonnet) has nickel-alloy plug disk and Exelloy body seat ring. Horizontal-lift check valve also has union body except 2-in., which has bolted cap. Piston-guided disks and renewable seats. Horizontal-swing check valve has screwed cap and tapped hole to facilitate regrinding. Size range of ¼ to 2 in.

Crane Co, 836 S Michigan Ave, Chicago, Ill.



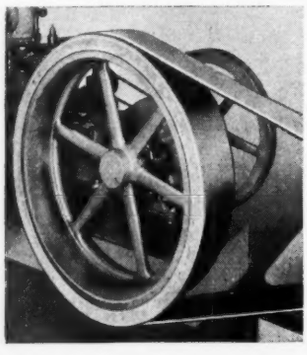
VIBROMETER

INSTRUMENT for measuring amplitude of vibration of structural or machine members has range of .001 to .030 in. amplitude. When needle point is held against vibrating part, motion of spindle is transmitted directly to vibrometer pointer (which appears as bright yellow against black background).

American Instrument Co, Inc, 8024 Georgia Ave, Silver Spring, Md.

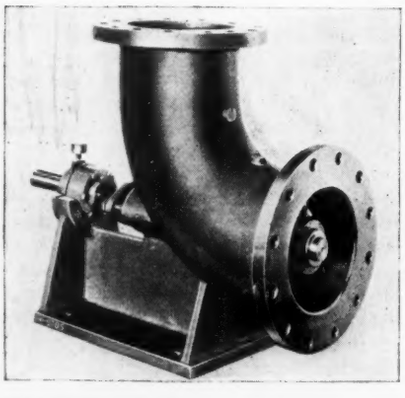
FIBRE LAGGING FOR PULLEYS AND FLYWHEELS

For increasing diameter of pulleys and flywheels, fibre lagging with improved clamp is made of same material as Rockwood paper pulleys. Compressed end-grain fibre-belt surface grips and pulls belt without slip. Made in any width and up to 72 in. in diameter. Is



also used in place of pulley coverings where more transmitting capacity is needed, provided 3 to 4 in. increased diameter is not objectionable. Illustration shows lagging on flywheel of a compressor.

Rockwood Mfg Co, 1801-2001 *English Ave, Indianapolis, Ind.*



ELBOW-PROPELLER CIRCULATING PUMPS

For handling water, semi-viscous liquids, etc, these elbow-propeller circulating pumps may be installed in pipelines for booster service, small number of vanes and large openings providing large streamline flow channel. Have internal bearings and ball thrust bearings. Range in capacity from 1000 to 2000 gpm, at heads up to 20 ft.

Worthington Pump & Machinery Corp. Harrison, N.J.

ERRATUM

Through a typographical error, the refractory insulations manufactured by Quigley Co, 56 W 45th St, New York, N. Y., were listed on page 82, Mid-December *Power*, as suitable for temperatures up to 220 F. This figure should be 2200 F. Also, in the same item, it was stated that the insulations had an approximate heat-storage capacity of 1/40th. This should have read, "an approximate heat-storage capacity of 1/60th that of firebrick walls of equal heat flow."

ATOMIZER HEAD FOR PAINT SPRAYING

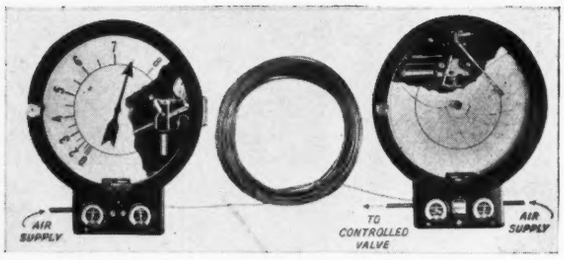
"Hollow-Air" atomizer head for Type MM and "Multi-Width" spray guns discharges impinging jets instead of solid jets of air. Applicable to either pressure or siphon feed. Due to spreading out of air in conical shape from jet in side wings, large soft area of air flattens paint, atomizing it to outermost edges of spray. Widths of spray 18 in. wide and upwards can be obtained.

Alexander Milburn Co, 1493 *W Baltimore St, Baltimore, Md.*

PIPE MACHINE *(right)*

No. 512-A "Tom Thumb" portable pipe machine rounds out line of ½ to 2-in. machines. Diehead is integral with carriage and threading dies are rigidly supported. Front-cutting diehead, together with close-grip front chuck, make it possible to handle pieces as short as 2½ in. Internal oiling system for dies and cutting tool. Flexible hose carries oil from pump to diehead intake valve, and flow of oil is controlled by 2-way thumb valve. Over-all length 34 in.; width, 21 in.; height 24 in.

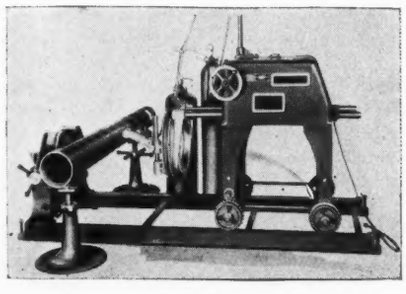
The Oster Mfg Co, 2057 E 61st Place, Cleveland, Ohio.



PNEUMATIC TRANSMISSION FOR REMOTE MEASUREMENT

Pneumatic remote-transmission system consists of transmitting indicating instrument at point of operation, and a receiver, which may be indicator or recorder, at remote master-control board. Remote transmission is balanced air pilot, mechanically actuated, built into indicating transmitter. Receiver is either an indicating or recording pressure gage, calibrated in terms of variables being measured. Air consumption is .016 cu ft of free air per min; ambient temperature change of 60 F affects readings less than 0.25%. Illustration shows indicating flow-transmitter at left, transmission tubing at center, and recording and controlling flow-receiver at right.

Brown Instrument Co, Philadelphia, Pa.



Power Lines

Application Made for International Hydro Project

Pigeon River Lumber Co, Grand Rapids, Wisconsin, has filed with Federal Power Commission its application for license for a power project on the Pigeon River in Cook County, Minn, and Ontario, Canada, which affects lands of the United States and tribal lands within the Grand Portage Indian Reservation. Pigeon River constitutes part of the international boundary between the United States and Canada.

The project consists of a storage reservoir at Arrow Lake with a dam in Arrow River at the outlet of Arrow Lake in the Province of Ontario, Canada; storage reservoirs at North Fowl Lake and South Fowl Lake with a dam on Pigeon River at the outlet of South Fowl Lake; a diversion dam in Pigeon River at a point about ½ mile above High Falls; a 9 ft woodstave conduit; a power house with installed capacity of about 5500 hp on the Canadian side of Pigeon River; and a 110,000-volt transmission line.

The energy to be generated will be used mainly for operation of pulp and wall-board mills and other wood manufacturing plants to be located at Pigeon Bay, and for the operation of paper mills and new mining developments on the Canadian side of the river, and to serve the communities along the north shore of Lake Superior.

Testing Laboratories Form Association

Representatives of 20 of the principal commercial laboratories in the country, at a meeting in Chicago in Nov, completed the organization of the American Council of Commercial Laboratories. One of the purposes of the Council will be

the promotion of the proper use of scientific testing methods for protection and certification of quality.

The following officers and members of an executive committee were elected to serve during 1938: president, Preston S Miller, Electrical Testing Labs, New York, N.Y.; vice-president, Monroe L Patzig, Patzig Testing Labs, Des Moines, Iowa; secretary, D E Douty, U S Testing Co, Hoboken, N.J.; and treasurer, A R Ellis, Pittsburgh Testing Lab, Pittsburgh, Pa. Members of the executive committee are James H Herron, James H Herron Co, Cleveland, Ohio; F B Porter, Southwestern Labs, Fort Worth, Tex.; and T A Wright, Lucius Pitkin Co, N. Y., N. Y.

ASHVE Annual Meeting In New York, Jan 24-28

The American Society of Heating & Ventilating Engineers will hold its 44th Annual Meeting, Jan 24-28, at the Hotel Biltmore, New York, N.Y. Concurrently with this meeting will be held the Fifth International Heating & Ventilating Exposition, Grand Central Palace, N. Y.

Equipment to be exhibited includes combustion apparatus, hydraulic apparatus, steam and hot-water heating equipment, ventilating and air-conditioning apparatus, controls, refrigeration, central heating, insulation, and metals and alloys.

At the engineers meeting, the following papers will be presented:

Tuesday, January 25

9:30 A M "Application and Economy of Steam-Jet Refrigeration to Air Conditioning," by A R Mumford and A A Markson

"Cooling-Tower Equipment and Its Relation to Water Conservation," by S I Rottmayer

2:00 P M Joint Session with National Warm-Air Heating and Air-Conditioning Assn

"Air Distribution from Side-Wall Outlets," by D W Nelson and D J Stewart

"Condensation within Walls," by F B Rowley, A B Algren and C E Lund

Wednesday, January 26

9:30 A M "Studies on Bacterial Control in Air Conditioning," by T S Carswell, J D Fleming and H K Nason

"Physiologic Response of Man to Environmental Temperature," by Dr F K Hick, Dr R W Keeton and Nathaniel Glickman

"Control of Body-Heat Loss Through Radiant Means," by Dr C A Mills and Dr Cordelia Ogle

"Summer Cooling Requirements of 275 Workers in an Air-Conditioned Office," by A B Newton, F C Houghten, Carl Gutberlet and R W Qualley

2:00 P M Joint Session with American Society of Refrigerating Engineers

"Control of Air Conditioning in Large, Medium and Small Buildings," by W E Zieber and S F Nichol

"Physiological Reactions and Sensations of Comfort under Various Atmospheric Conditions," by C E A Winslow, L P Herrington and A P Gagge

"Performance Tests of Asbestos Insulating Air Duct," by R H Heilman and R A MacArthur

Thursday, January 27

9:30 A M "Heating Effects of Artificial Lighting on Air Conditioning," by Walter Sturrock

"Comparative Analysis of Office-Building Air-Conditioning Systems," by J R Hertzler

"Heating and Ventilating the Lincoln Vehicular Tunnel," by C W Murdock

Friday, January 28

9:30 A M "Drop in Skin Temperature and Sense of Coolness with Various Air Conditions," by F C Houghten

"Study of Methods of Control and Types of Registers as Affecting Temperature Variations in the Research Residence," by A P Kratz and S Konzo

"Heat Transfer Through Single- and Double-Glazed Steel Sash," by M L Carr, R A Miller, A C Byers and Leighton Orr

AWS Sponsors Lectures

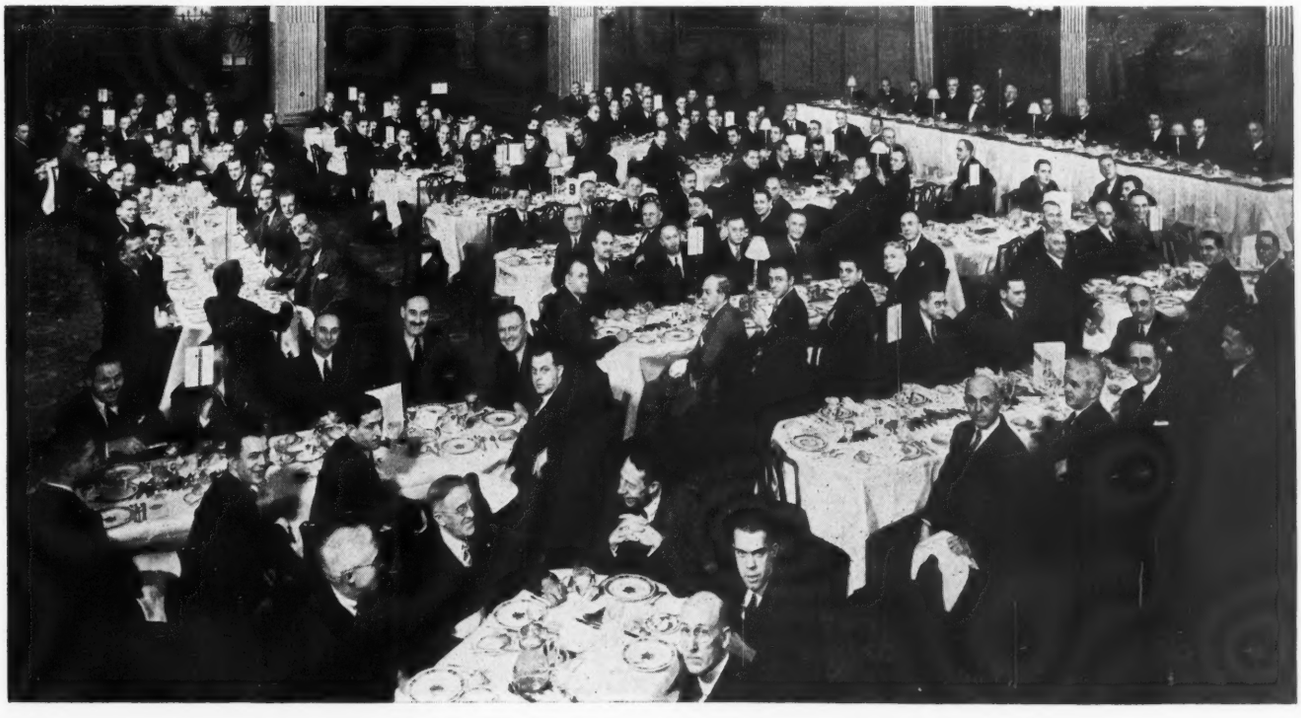
The American Welding Society, New York Section, in conjunction with Polytechnic Institute of Brooklyn (N.Y.) will hold a series of lectures on welding beginning Jan 11, at 99 Livingston St, Brooklyn, N. Y. Lectures will cover welding processes, applications and design.

Transmission Council Holds Annual Meeting

A note of courage and confidence in the industrial future of this country was expressed at the annual dinner of the Power Transmission Council, Inc, held at the Hotel Roosevelt, New York, N.Y., Dec 2. Charles E Brinley, chairman of the board, Power Transmission Council, presided. Dr Harvey N Davis, president, Stevens Institute of Technology, spoke on "The Engineer of the Future" and expressed the opinion that the future engineer would be very much like he is today, but filling an even more important position in our national life. Glenn Griswold, publisher of "Business Week", talked on "Industry's Future and the Nation" and outined the forces at work favorable to a business revival, which included practically all economic factors except public confidence.

W W French, chairman Merchandising Committee, Power Transmission Council, took for his subject "Selling Profit Opportunities to Industry", and said that he had no fear for future business prospects in this country and paid high tribute to the courage of the men who, during the last business depression when courage was really needed, laid the foundation upon which the present Power Transmission Council was built. He expressed the opinion that their work had helped materially in industrial recovery by cutting production costs and would continue to do so at an accelerating rate.

Photograph of the annual dinner appears below.



Sea-Going Monotube Boiler

A period of commercial service has indicated that the "topping" installation recently made on the "S S Kertosono" has effected marked improvements in both power and economy. Feature of the modernization is a 50,000-lb-per-hr-Sulzer monotube boiler which occupies the space of one of the original Scotch marine boilers and provides more capacity than all five of the old boilers. Steam at 900 lb and 710 F is supplied to a new high-pressure turbine exhausting into the old low-pressure machines.

Also unique is a combined feedwater and oil pump. Triplex cylinders for boiler feed and oil cylinders for fuel-oil feed and oil supply for the hydraulic-control system are driven from a common crankshaft. The combined pumping unit is powered by two steam cylinders.

POWER'S History

Power was founded in 1884 by E P Harris and H M Sweetland. With it was incorporated *Steam*, which had been started by N Hawkins in Chicago two years earlier.

In 1903 *Power* purchased and absorbed *Science and Industry*, which was a consolidation of a number of periodicals, namely, *Home Study Magazine, Home Study for Machinists, Mechanic's Magazine, Home Study for Building Trades, Building Trades Magazine, Home Study for Electrical Workers* and *Steam Electric Magazine.*

In 1908 it absorbed *The Engineer's Review*, of Cleveland, and *The Engineer*, of Chicago, the latter being a consolidation of *The Safety Valve, Lord's Power and Machinery Magazine, The Stationary Engineer, Engineers and Power Users Magazine, Steam Engineering* and *The Mechanical Engineer.* When *The Engineer* was purchased, the name of the combined magazine was *Power and The Engineer.* The title was condensed to *Power* in 1911. All rights to the above titles reserved.

OBITUARIES

I H Barbee, manager of Link-Belt Co's Atlanta, Ga., plant, died in Philadelphia Nov 4.

P E Fansler, editor and publisher of *Air Conditioning & Oil Heat*, died Nov 7. Graduated from Purdue University in 1901, he was for the next few years assistant electrical engineer for the St. Louis World's Fair. Later he was associated with various marine-engine companies and consulting firms. Previous to the organization of his own magazine in 1928, he was on the staff of *Heating & Ventilating.*

S Harold Greene, 57, former president and treasurer of Mutual Boiler Insurance Co, Boston, Mass., died in Newtown, Mass., Nov 19.

Albert L Deggs, 62, for the past 9 years superintendent of maintenance for the Northeastern Div of New England Power Co, died in Lowell, Mass., Nov 29.

Dr Gardner C Anthony, 80, for 29 years dean of Tufts College engineering school until his retirement in 1927, past-president of the Society for Promotion of Engineering Education, died in New Rochelle, N.Y., Nov 29.

Theodore N Kelsey, chief engineer of Lawrence Mfg Co for 40 years until his retirement in 1927, died in Lowell, Mass., Nov 21.

MEETINGS

National Electrical Manufacturers Association—*Midwinter meeting, Waldorf-Astoria Hotel, New York, N. Y., February 7-12, W J Donald, managing director, 155 E 44th Street, New York, N. Y.*

American Institute of Electrical Engineers—*Winter convention, New York, N. Y., January 24-28. H H Henline, national secretary, 33 W 39th St, New York, N. Y.*

American Institute of Mining and Metallurgical Engineers—*Annual meeting, Engineering Societies Building, New York, N. Y., Feb 14-18.*

American Society of Heating & Ventilating Engineers—*Annual Meeting, Jan 24-28, Biltmore Hotel, New York, N. Y. A V Hutchinson, secretary, 51 Madison Ave., New York, N. Y. Concurrently with the meeting will be held the 5th International Exposition of Heating, Ventilating and Air Conditioning at the Grand Central Palace, New York, N. Y., Charles F Roth, manager.*

American Society of Refrigerating Engineers—*Annual meeting, Jan 26-28, Roosevelt Hotel, New York, N. Y., David L Fiske, secretary, 37 West 39th St, New York, N. Y.*

National Warm Air Heating and Air-Conditioning Association — *Winter convention, Jan 24-26, Roosevelt Hotel, New York, N. Y. Allen A Williams, managing director, 50 W Broad St, Columbus, Ohio.*

PERSONALS

Albert F Spitzglass, former vice-president in charge of engineering, and Maurice J Zucrow, former director of research, Republic Flow Meters Co, have opened their own offices and laboratories at 415 N La Salle St, Chicago, Ill., where they will engage in the practice of consulting engineering and in the design and development of new products.

Robert Schuster has been appointed by Lincoln Electric Co, Cleveland, Ohio, to the sales staff of their Pittsburgh office, 926 Manchester, Blvd.

W C Flanders has been appointed sales manager of Worthington-Gamon Meter Co, Harrison, N.J. He succeeds G H Gleeson, who recently resigned as vice-president in charge of sales.

Murray B Wilson, associated with Armco since 1923, has been named manager of the New York sales district of American Rolling Mill Co, Middletown, Ohio.

Charles E Greene, mechanical and electrical engineer for 10 years with Metcalf & Eddy, Boston, Mass., has joined the staff of Cleverdon, Varney & Pike, consulting engineers, 46 Cornhill, Boston, in a similar capacity.

Dr G M L Sommerman of the Physical Laboratory staff of the American Steel & Wire Co, Worcester, Mass., has received the Alfred Noble prize for the best technical paper published by any member under 30 years of age of either the ASCE, the ASME, the AIEE, or the AIMME. The award was made to Dr. Sommerman for a paper, "Properties of Saturants for Paper-Insulated Cables", presented before the AIEE last June.

E P Cramer, Atlanta Gas Light Co, Atlanta, Ga., was made chairman of the Gas-Engine Power Committee of the Industrial Gas Section, American Gas Assn, and Ralph H Wenner, Ohio Fuel Gas Co, Toledo, was made vice-chairman.

A A Nelson has joined the sales force of Robins Belt Conveying Co, New York, N.Y., for eastern New York and western Connecticut.

C D Meals has been appointed chief engineer of Wire Rope Div, Bethlehem Steel Corp, Williamsport, Pa., terminating his connection with B Greening Wire Co, Ltd, Hamilton, Ont., where he has been since 1931.

Henry C Hill, 132 Wyoming Ave, Cincinnati, Ohio, has been appointed sales representative for Beaumont Birch Co, Philadelphia, Pa.

T M Robie has been named manager of diesel sales for Fairbanks, Morse & Co, Chicago, Ill.

BUSINESS ITEMS

American Leather Belting Assn, New York, N.Y., at its annual meeting in December, elected the following officers: president, Mark M Jones, Akron Belting Co.; 1st vice-president, J E Rhoads, J E Rhoads & Sons; 2nd vice-president, G L Abbott, Alexander Bros Inc; treasurer, A H Rahmann, George Rahmann & Co; and secretary, J L Nelson.

Fal Corp, Milwaukee, Wis., has appointed Transmission Engrg Co, 116 New Montgomery St, San Francisco, as its representative in northern California.

Indicator Corp, Newark, N. Y., has appointed A E Carpenter president, succeeding F A Schiller, resigned. Edward A Tunis has been elected vice-president and general manager.

Lincoln Electric Co, Cleveland, Ohio, has opened a new sales-engineering office at Atlanta, Ga., 412 Title Bldg, under the management of Robert Daniels.

Roots-Connersville Blower Corp, Connersville, Ind., has appointed the following sales representatives for turbine pumps: A N Goff, 94 8th St, Fond du Lac, Wis.; F W Bartling and G T Oberklein, 950 E Court St, Cincinnati, Ohio.

Graton & Knight Co, Worcester, Mass., recently christened its traveling laboratory, which will cover every industrial section of the U.S. The laboratory

will demonstrate modern mechanical-drive systems and show how to solve power-transmission problems.

ALLIS-CHALMERS MFG CO, Milwaukee, Wis., has opened an office in Syracuse, N.Y., at 943 W Genessee St, with G H Garden as sales engineer in charge.

FOOTE BROS GEAR & MACHINE CORP has appointed Walter A Hoppe, 948 S Grand Ave, Los Angeles, Calif, as representative in southern California.

LINK-BELT CO, Chicago, Ill., has made the following changes in personnel: Harold L Hoefman has been appointed manager of plant, warehouse and sales office at Atlanta, Ga.; George A Paige manager of warehouse and sales office in Detroit; Laurence O Millard district sales manager in Pittsburgh; and Paul V Wheeler district sales manager in Cleveland.

COMMITTEE OF TEN, Coal and Heating Industries, has moved its office to Suite 520-22, 307 N Michigan Ave, Chicago, Ill.

STOCK ENGRG CO, Cleveland, Ohio, has appointed Stanley Sales Co, 1440 Broadway, New York, N.Y., as representative in New York.

NEW YORK BELTING & PACKING CO, Passaic, N.J., has appointed Edward Joy Co, 133 Market St, Syracuse, N.Y., as distributor for Syracuse.

HOWESTEAD VALVE MFG CO, Coraopolis, Pa., has appointed the following sales representatives: C A Randorf, 220 Delaware Ave, Buffalo, N.Y.; Beeler-MacWilliams, Inc, 1002 Hills Bldg, Syracuse, N.Y.; W E Mushet Co, 11 SW Front Ave, Portland, Ore.; Clowe & Cowan, Inc, 401 Harrison St, Amarillo, Tex.; Paul R Winston Co, 206 Construction Bldg, Dallas, Tex.; Waterworks Equipt Co, 149 W 2nd South St, Salt Lake City, Utah; and Tazewell Buchanan, 2620 Grace St, Richmond, Va.

JENKINS BROS, New York, N.Y., has opened a new branch office and warehouse at 376 Spring St, Atlanta, Ga.

NORTHERN EQUIPT CO, Erie, Pa., has accepted resignation of Alden L Covill, Rochester, N.Y., representative. Succeeding Mr. Covill will be Charles A Randorf, 220 Delaware Ave, Buffalo, N.Y.

STRAWS

Pointing the way business winds blow

CALIFORNIA — Board of Trustees, Olive View, contracted Ralph E. Homann Co, Los Angeles, for addition to boiler plant at institution. Cost about $30,000.

City and County Commissioners of San Francisco plan central-heating plant in multi-story hospital at Lagunda Honda Home. Cost about $700,000. Dodge A Riedy, 821 Market St, and Frederick H Meyer, Kohl Bldg, San Francisco, architects.

Coalinga High School District, Coalinga, plans central-heating plant in multi-story junior high school. Bond issue of $230,000 has been approved. W D Coates, Rowell Bldg, Fresno, architect.

TO THE FIRST DIESEL

This memorial tablet was unveiled at the Augsburg Works (Germany) of the M A N, Oct 4, 1937, commemorating the first diesel engine. The legend on the tablet reads, "On this spot, the first diesel engine in the world was originated in the years 1893-97."

Puritan Ice Co, Lompoc, plans 1-story addition to plant, 50x50 ft. Cost about $30,000, with equipment. Fred Bacon, general manager.

Wilmington Gasoline Co, Wilmington, Los Angeles, plans two welded-steel submarine pipelines, 8-in. for wet-gas transmission, and one 4-in. similar pipeline for dry-gas transmission across entrance channel to Long Beach harbor. Application has been made for permission.

Escondido Orange Association, Escondido, will begin construction of 2-story and basement pre-cooling plant, 60 x 100 ft., and 1-story ice-manufacturing plant, 30 x 150 ft. Cost over $100,000.

COLORADO — Denver, Rio Grande & Western R R Co, Denver, has approved plans for addition to steam power house at terminal at Pueblo, including boiler units and auxiliaries. Cost about $40,000.

Bureau of Reclamation, Denver, plans motor-driven pumping plant for Glendive unit of Buffalo Rapids Irrigation Project, Mont. Cost about $400,000.

Frying Pan Light & Power Co, Basalt, plans generating plant on Frying Pan River, near Basalt, for light and power service for municipality, which has granted 20-yr franchise. Cost close to $100,000, with electrical distributing lines. Prouty Brothers Engrg Co, Exchange Bldg, Denver, consulting engineer.

CONNECTICUT — New York, New Haven & Hartford R R Co, New Haven, contracted Ross & White Co, Chicago, Ill., for new coaling station at Springfield, Mass., capacity of 175 tons per day. Cost over $50,000.

FLORIDA — People's Water & Gas Co, 637 Washington Ave, Miami Beach, plans welded-steel pipeline across Biscayne Bay connecting Miami and Miami Beach, for high-pressure gas transmission.

New Smyrna Beach will make extensions in municipal electric plant. Cost over $75,000.

ILLINOIS — Swift & Co, Union Stock Yards, Chicago, plans boiler house at 3-story meat-packing plant on Meadow Rd, Asheville, N. C. Cost about $100,000.

Moline plans boiler and accessories, turbine-generator in power house used for municipal waterworks pumping station. Robert M Benell, city engineer.

Sears, Roebuck & Co, West Arthington St, Chicago, plans central-heating plant in 3-story department store at Harford Rd and North Ave, Baltimore, Md. Cost about $1,000,000. Nimmons, Carn & Wright, 333 N. Michigan Ave, Chicago, architects.

Moody Bible Institute, 153 W Institute Pl, Chicago, will install central-heating plant in 12-story administration building at 812-928 LaSalle St. Cost about $500,000. Thielbar & Fugard, 520 N. Michigan Ave, architects.

INDIANA — Board of School Trustees, Evansville, plans central-heating plant in 3-story vocational training school. Cost about $250,000. Fowler & Legeman, Central non Bldg, Evansville, architects.

Continental Diamond Fibre Co, South Campbell St, Elkhart, contracted Smith-Nuppanau Co, Elkhart, for 1-story addition to boiler plant; also to Continental Chimney Co, Chicago, for 125-ft stack. Cost about $40,000.

IOWA — Bloomfield contracted Fairbanks, Morse & Co, Chicago, for 450-hp diesel-generator unit and auxiliaries for municipal electric plant.

Estherville, contracted Busch-Sulzer Bros Diesel Engine Co, St. Louis, Mo., for 1285-hp diesel and accessories for municipal power plant, at $75,142.

John Morrell & Co, Ottumwa, awarded contracts for extensions in power house at local meat-packing plant, to include turbine-generator and auxiliary equipment. Cost over $90,000.

Primghar contracted L A Kepp Contracting Co, Rochester, Minn., for municipal power plant, at $105,377, including two 225-hp diesel-generator units. Buell & Winter Engineering Co, Insurance Exchange Bldg, Sioux City, Lowa, consulting engineer.

Emmetsburg contracted Pittsburgh-Des Moines Steel Co, Des Moines, for artificial-gas plant and distributing pipeline, at $52,250. Complete project will cost about $80,000. Gas Service & Engrg Corp, 3615 Olive St, St. Louis, Mo., cons. engineer.

Board of Education, Tama, plans central-heating plant in 2-story high school. Cost about $145,000. Thorwald Thorson, Forest City, architect.

State Board of Control, State House, Des Moines, contracted F B Dickinson Co, 1118 Mulberry Ave, Des Moines, for boiler plant at state hospital at Cherokee, at $57,843. Cost about $95,000. Henry J Liebbe, State House, Des Moines, state architect.

KANSAS — Ellinwood will place contract soon for 600-hp engine-generator unit and accessories for municipal power plant.

Midwest Cold Storage Co, Fifth St and Kaw River, Kansas City, plans 3-story addition to cold-storage and refrigerating plant. Cost over $100,000. George E Wells, Inc, Security Bldg, St. Louis, Mo., consulting engineer.

Construction Service, Veterans' Administration, Washington, D. C., will receive bids until Jan 4 for refrigerating equipment for institutions at Wadsworth, as per plans and specifications on file.

KENTUCKY — Williamstown plans municipal electric plant. Bond issue of $90,000 has been authorized. Thomas D Wells, mayor, in charge.

City Commissioners, Somerset, plan central-heating plant in new multi-story hospital. $200,000 being arranged.

LOUISIANA — Roland J Robert, Burnside, plans power house at new cane-sugar mill at Gonzales. A pumping station will be built. Cost close to $900,000.

East Carroll Parish School Board, Lake Providence, plans central-heating plant in high and grammar school. Cost about $200,000. Financing through Federal aid. H H Land, Ouachita National Bank Bldg, Monroe, architect.

Ruston will ask bids early in March for motor-driven pumping machinery in con-

NEW PLANT CONSTRUCTION

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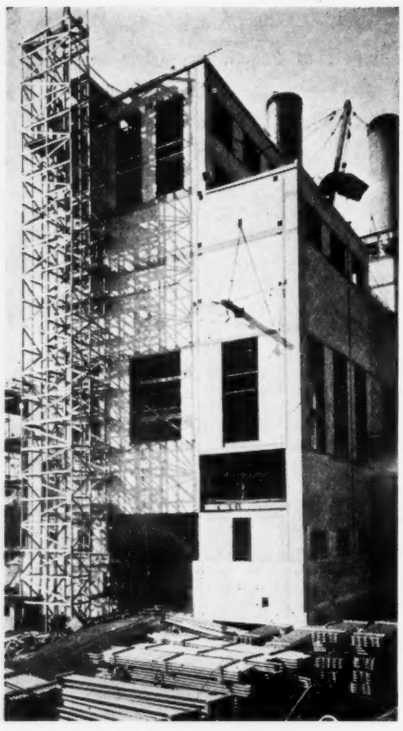


SOUTH MEADOW EXTENSION

Under construction is extension of South Meadow station, Hartford Electric Light Co, which will house a 400,000-lb-per-hr unit to deliver steam at 850 lb and 900 F, and a 40,000-kw addition to the turbine plant. Stone & Webster Engrg Corp is designing and constructing engineer

nection with new sewage-disposal works. Cost about $135,000. L J Voorhies, City Hall, Baton Rouge, engineer.

Department of Public Property, New Orleans, contracted Carrier Corp, for air-conditioning system in municipal auditorium, at $180,000.

Jackson Parish Police Jury, Jonesboro, plans central-heating plant in 4-story courthouse and jail building. Cost about $250,000. J W Smith & Associates, Monroe, architects.

Board of Trustees, Louisiana Polytechnic Institute, Ruston, plan steam plant, mechanical laundry and engineering building. Cost about $425,000. E S Richardson, president in charge.

MARYLAND — West Baltimore Ice Co, 415 North Poppleton St, Baltimore, plans 1-story addition to cold-storage warehouse and ice plant. Cost estimated at $45,000. Herman J Fenker is head.

Baltimore has low bid from Dravo Corp, Neville Island, Pittsburgh, at $135,442 for equipment for mechanical-draft plant at Rock River sewage-treatment works, including motor-driven blower units and auxiliary apparatus. Contract will be awarded soon.

MASSACHUSETTS——Water Works Dept. Worcester, plans pumping plant for water system in North Worcester and Tatnuck district, with motor-driven pumping units. Cost close to $250,000.

E M Loew's Theatres, 216 Tremont St, Boston, plan central-heating plant in theater building at North Adams, Mass. Cost about $130,000. Mowall & Rand, 261 Franklin St, Boston, architects.

Department of Public Buildings, City Hall, Cambridge, plans power house at Cambridge Tuberculosis Hospital, 2-story, 40 x 80 ft. Cost over $175,000. Edward T P Graham, 171 Newbury St, Boston, architect.

Worcester Brass & Electro Plating Co, 316 Shrewsbury St, Worcester, contracted

(*continued on page* 126)

Conn., Bridgeport—United Illuminating Co., 1119 Broad St., plans transformer plant, Housatonic Ave. and Congress St. $40,000 or more. Private plans.

Ga., Atlanta—Dixie Terminal Building Co., c/o J. C. Robertson, dir., U. S. Cold Storage Corp., 500 East 3rd St., Kansas City, Mo., revised plans by A. E. Epstein, archt. and structural engr., 2001 W. Pershing Rd., Chicago, Ill., 7 story 156x182 ft. concrete, brick cold storage building, Central Ave. and Wall St. Concrete foundations were sunk seven years ago, costing about $100,000. $750,000 to complete project using present foundation.

Fla., Chattahoochee—City plans electric plant. $400,300. P.W.A. project.

Ill., Springfield—City making final plans power plant addition, incl. 2 and 3 boilers and generators. $425,000. Burns & McDonnell Eng. Co., 107 West Linwood Blvd., Kansas City, Mo., engrs.

Ind., Huntington—Acme Eng. Co., L. H. Bowman, pres., plans power project on Salamonie River, 3 dams and power houses, to develop 2,000 hp., in Huntington and Wabash Counties. $600,000. Project up for consideration and approval of Federal Power Comn.

Ia., Maquoketa—Bids Jan. 6, by City, plant improvements, incl. heavy duty diesel oil engine, alternate, current generator, exciter and storage tank, miscellaneous equipment, switchgear, cooling system circulating pumping unit. $95,000.

Ky., Louisville—Bids Jan. 10, by Louisville Water Co., 435 South 3rd St., constructing Sect. 2, four 15 M.G.D. 200 ft. head vertical shaft, electrically driven pump units erected with appurtenances on River Pumping Station, Sect. 4, four 24 in. automatic cone valves. Sect. 5, one motor driven drainage pump and two vertical shaft, electric driven drainage pumps, Sect. 6, building alterations, incl. flood doors and other miscellaneous work, Sect. 7, earth filling, 18,000 cu. yd. L. S. Vance, 435 South 3rd St., engr. in charge.

La., New Orleans—Bids Jan. 4, by Bd. Administrators Charity Hospital, constructing auxiliary buildings, incl. power and refrigerating plant, warehouse, woodworking shop building and animal house. Part of $8,000,000 P.W.A. project. Weiss, Dreyfous & Seiferth, 600 Maison Blanche Bldg., archts.

Md., Hagerstown—Municipality soon takes bids electric light and power plant. $200,000. Wood & Kirkpatrick, Stock Exchange Bldg., Phila., Pa., engrs.

Mass., Peabody—City, Electric Light Dpt., P. H. Tumulty, mgr., making surveys new electric light plant, incl. boilers and turbines. A. L. Nelson, 31 St. James Ave., Boston, engr.

Mich., Shelby—Municipality plans Diesel electric power plant.

Minn., Madelia—City, C. E. Seymour, clk., will take new bids in January, constructing power house, electrical generating equipment and distribution system. Burlingame, Hitchcock & Estabrooke, 521 Sexton Bldg., Minneapolis, engrs.

Minn., Sleepy Eye—City, A. J. Thomas, clk., making plans furnishing, installing engine and generator, cooling tower, etc., and making interior alterations to building at municipal power plant. About $80,000. G. M. Orr & Co., 542 Baker Arcade Bldg., Minneapolis, engrs.

Mo., Chillicothe—City, Bd. P. Wks., plans constructing power plant addition and furnishing new boilers, turbines and piping. $300,000. Henrici-Lowry, 114 West 10th St., Kansas City, Mo., engrs.

Neb., Franklin—City, considering the advisability of installing another generating unit for municipal plant as present equipment not quite sufficient for generating power needed.

Neb., Grand Island—City Council considering installation new generator and boiler in municipal light plant. R. L. Harrison, city engr.

Neb., Kearney—State Bd. Control C. W. Eubank, chn., Lincoln, voted favorably to construct power house building at State Tubercular Hospital. $45,000. J. Helleberg, Kearney, archt.

N. Y., Brooklyn—Dpt. Hospitals, 125 Worth St., New York, plans by John Russell Pope & D. Higgins, 542 5th Ave., New York, constructing electric steam power plant for Greenpoint Hospital, 288 Jackson St. $40,000.

N. Y., Buffalo—Buffalo Niagara & Eastern Power Co., c/o Niagara Hudson Power Co., Buffalo, indefinitely postponed constructing steam electric power plant. $8,000,000. Private plans.

N. Y., Corona—Interborough Rapid Transit Co., 165 Bway., plans by F. W. Gardiner, c/o owner, constructing 1 story sub-station for power plant, 120th and Roosevelt Ave. $70,000.

N. C., High Point—City plans hydro-electric plant on Yadkin River. To exceed $5,000,000. Will secure advance grant of $144,000 for preliminary survey. Murray and Flood Eng. Co., 369 Lexington Ave., New York, engrs.

O., Cleveland—City, F. O. Wallene, dir. Public Utilities, completed preliminary survey constructing light plant addition and alterations, incl. 25,000 kw. turbo-generator, bolstering transmission system and modernization of street lighting system, East 53rd St. and Lake Erie. $3,000,000. L. O. Quayle, 105 City Hall, ch. engr. Peter F. Loftus, Oliver Bldg., Pittsburgh, Pa., consult. engr.

O., Columbus—City plans 50x90 ft., generator station and installing 2 gas engines. $225,000. P. W. Maetzel, city engr.

O., Greenfield—City plans improvements to municipal water and light plant, incl. new turbine generating unit, rehabilitation of boilers and alterations of plant building. $100,000.

O., Lockland — Joslin-Schmidt Co., plans power plant and packing plant addition. $40,000.

Okla., Blackwell—City, c/o D. Randall, mayor, bids about Jan. 4 (tentative date), 4,000 kw. turbine generator for improving existing power plant. $300,000. Black & Veatch, 4706 Bway., Kansas City, Mo., engrs.

Okla., Edmond — City made preliminary plans constructing municipal light and power plant. $75,000. Engineer not appointed.

Okla., Marlow—City voted bonds constructing 500 hp. diesel engine and generator for municipal light plant. $55,000. V. V. Long & Co., Colcord Bldg., Oklahoma City, engrs.

Okla., Seminole — City made preliminary plans constructing municipal light and power plant. $100,000. R. N. Geer, Seminole, engr.

Pennsylvania—U. S. Eng., Federal Bldg., Pittsburgh, Pa., making plans constructing Red Bank Flood Control Dam, 15 kw. power plant for dam operation. $6,000,000. W. E. R. Covall, Federal Bldg., Pittsburgh, ch. engr.

Pa., McKeesport—National Tube Co., Frick Bldg., Pittsburgh, plans brick, steel power house, on plant property. May furnish part power for Carnegie Illinois Steel Company's Irvin Works. Private plans.

S. D., Flandreau—City, on a previous election voted bonds to build and equip municipal light plant. Now the city authorities and Union Public Service Co. have reached agreement whereby city can buy present plant from this service company for $77,500. A date will be set for special election to vote on bonds for last named amount.

Tenn., Chattanooga—Lookout Oil & Refinery Co., 4608 Kirkland Ave. (subsidiary Armour & Co., 221 North LaSalle St., Chicago, Ill.), plans power house and factory building. $100,000 incl. equipment. Plans being drawn by company architect in Chicago, Ill.

Tex., Weatherford — City, G. A. Holland, mayor, voted bonds to finance construction of electric power distribution plant, consisting of generating unit, power transmission or distribution lines, power plant building. $250,000. Engineer, c/o City Eng. Branch, engr.

Va., Winchester—Winchester Woolen Co. plans power plant. $40,000.

Wash., Seattle—Bur. Yards & Docks, Navy Dpt., Wash., D. C., soon takes bids on revised plans improving power plant at Sand Point Naval Air Station. $25,000. Cancelled bids to have been opened Nov. 24.

Wis., Tomaliz—Wisconsin Pub. Serv. Co., 1029 North Marshall St., Milwaukee, plans constructing hydro-electric project on Wisconsin River, near here, and constructing power transmission line from Tomaliz to Wausau. $1,657,000.

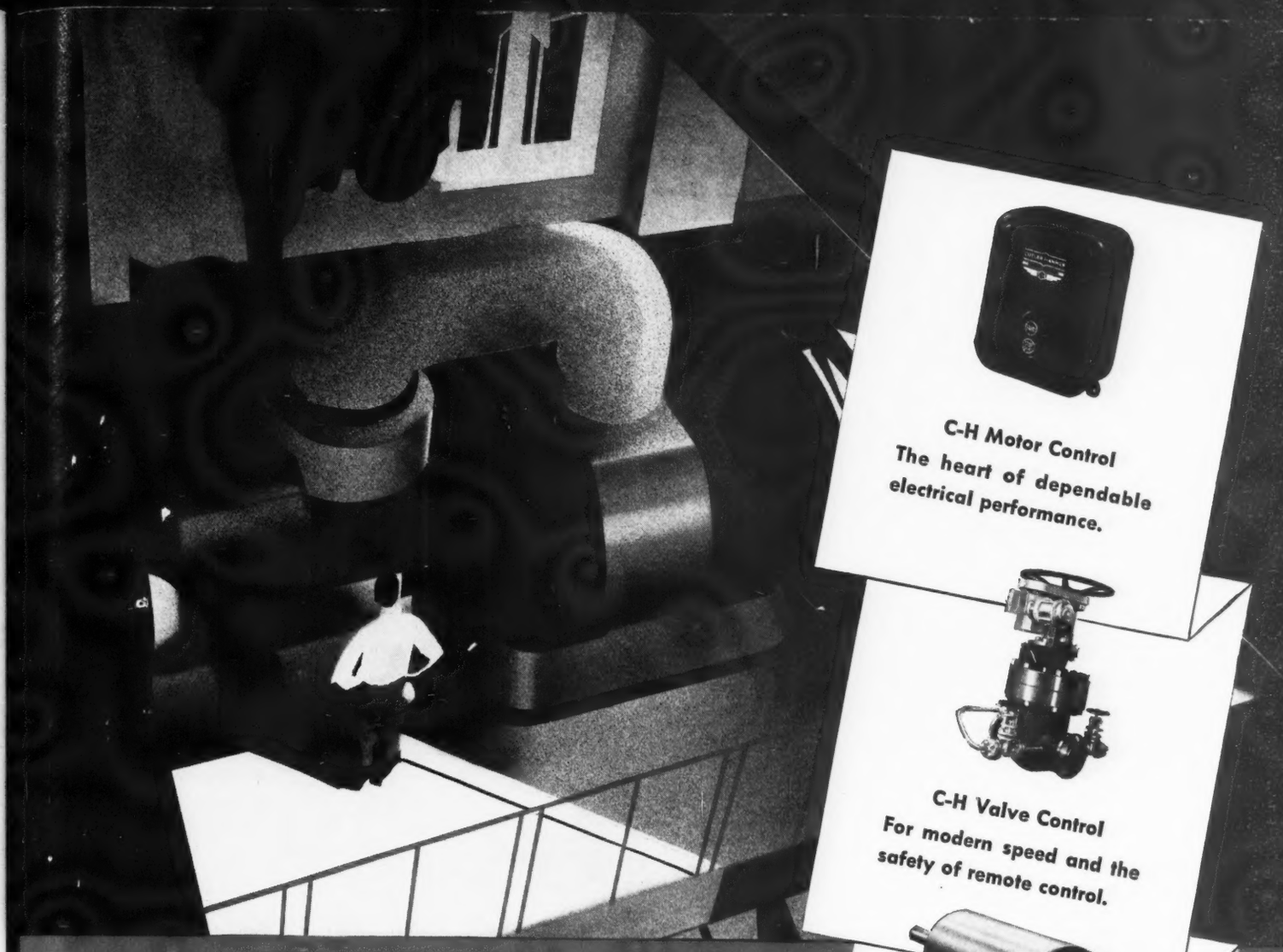
Alta., Red Deer—City, R. S. Gillespie, clk., ratepayers to vote on construction electrical power plant. $90,000.

B. C., Cowichan Lake—Crofton Export Co., 678 Howe St., Vancouver, plans erecting and equipping saw mill, power plant, machine shop and blacksmith shop. Lakefront. $200,000. Interested in prices all materials and equipment.

B. C., Dawson Creek—Dominion Electric Power Co., Ltd., plans electric power plant. $75,000.

Ont., Cornwall—City, ratepayers vote against erection municipal power plant. $100,000.

Ont., Welland—Hydro-Electric Comn., H. F. Shearer, mgr., plans constructing 6,000 kw. sub-station, Major St. $85,000. Private plans.



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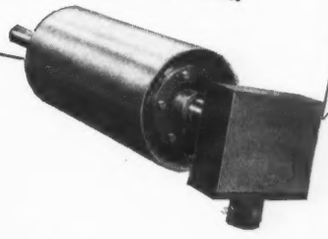

C-H Magnetic Separators
For continuous, automatic segregation of magnetic materials.

New Problems Confront the Power Plant Designer

● The *modern* power plant of today and tomorrow is designed to function automatically. Everything from fuel unloading and ash handling to the final distribution of electrical energy is regulated by fully automatic or semi-automatic control.

This is symbolic of the tremendous improvement that has taken place in power plant design and construction . . . symbolic too of the many intricate problems of Motor Control now confronting the Power Plant Designer. Each problem often involves a huge number of technical factors to be correlated and applied.

It is significant, therefore, that foremost Power Plant Designers and Engineers turn to Cutler-Hammer for sound counsel. This indication of C-H leadership in the field of Motor Control, is seconded by the ever increasing proportion of Power Plant Control installations bearing the insignia—CUTLER-HAMMER. Today, as in years past, C-H Counsel as well as C-H Equipment is the most relied upon in the world . . . the result of unequalled experience. CUTLER-HAMMER, Inc., *Pioneer Manufacturers of Electric Control Apparatus*, 1358 St. Paul Ave., Milwaukee, Wis.

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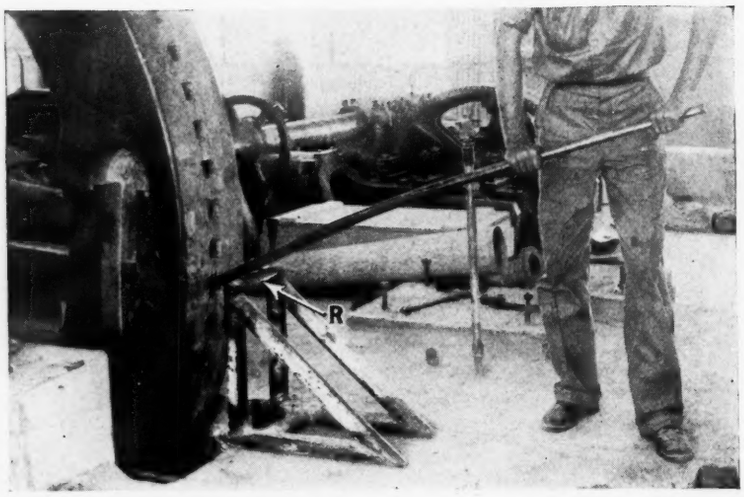


Arc-Welded Flywheel Jackbar Stand

FABRICATED from scrap 2-in. pipe, and with a roller of 2½-in. pipe across the upper cross member to lessen friction on the bar, is this jackbar stand for barring over heavy internal-combustion engines. Ears on its base lock over the edge of the flywheel pit and prevent the stand from sliding away. As the stand is made in one piece, there is no adjustment to work loose under strain, and ample width at the base prevents overturning as the wheel revolves.

A welded stand such as this one brings the fulcrum at the most advantageous point for application of force. The sliding sleeve on the bar rest *R* permits the bar to move out as the wheel turns, regardless of the diameter of the flywheel or its setting with regard to station-floor level.

An ordinary crowbar is used with the stand. Both may be used at will on either side of the wheel without need of holes, fixtures or other floor aids other than the edge of the flywheel pit.

Philadelphia, Pa. B R THOMPSON

Reconditioned Valve Improves Regulation

A REDUCING valve on our heating system was giving poor pressure regulation, especially at low heating loads when pressure in the heating coils increased to a point at which the low-pressure steam trap would not work. We dismantled the reducing valve and found ports and piston badly cut. We rebored valve ports to obtain clean seating surfaces, increasing the port opening from ⅞ to 15/16 in.

Piston surfaces were built up uniformly by welding, using a bronze rod. The piston was then turned and polished to a close sliding fit in the ports. The increase in the size of the bore has increased valve capacity somewhat, but pressure regulation is as good as ever.

Milwaukee, Wis. L M LARSON

What Price Efficiency in Centrifugal Pumps?

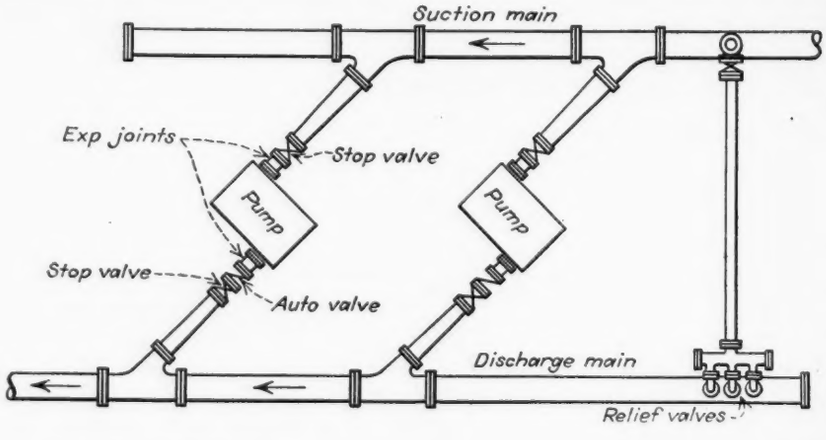
MAXIMUM efficiency is secured in centrifugal pumps only when they are operated at or near conditions of head and output for which they are designed. Any considerable or prolonged departure from these conditions, as may be caused by variations in demand, extensions and increases in the network of discharge mains, may cause a reduction in efficiency that will make advisable changing the impeller or using a variable-speed drive.

There is an intimate relation between first cost of a pump and efficiency. A centrifugal pump of comparatively moderate cost can do a large amount of work. Cost of power to operate the pump may equal its initial cost in a relatively short time. An actual instance will illustrate this.

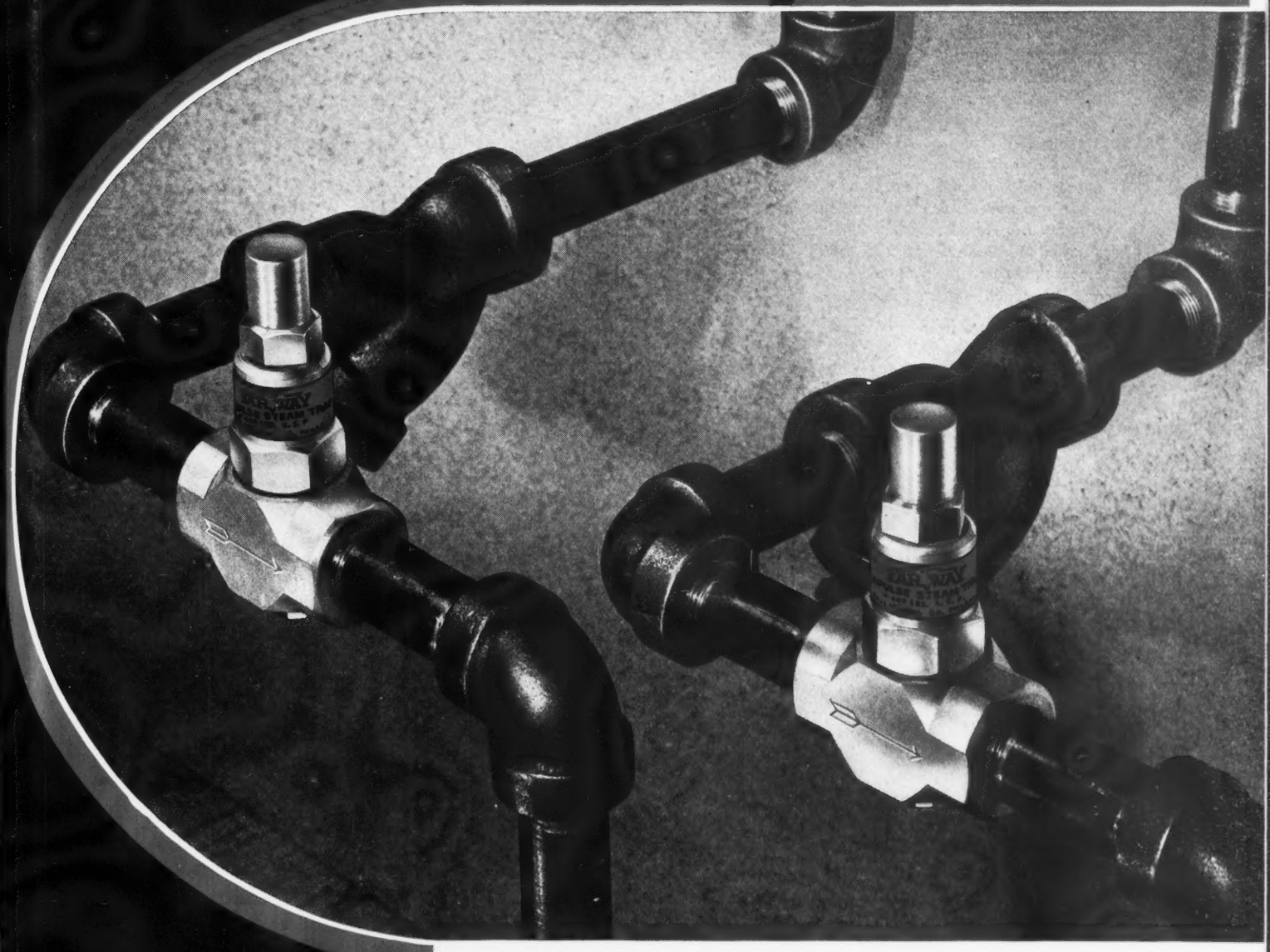
A centrifugal pumping unit, consisting of two single-stage pumps in series, direct connected to a 500-hp synchronous motor, with semi-automatic reduced-voltage starting equipment, cost complete less installation, $8,000. The unit was designed for an output of 8,000,000 gpd against a discharge head of 125 lb. In operation it matched these conditions almost exactly, maintaining correct pressure and delivering at the rate of 5,600 gpm. The efficiency of the combined unit was 80.4%.

It was found that energy consumption for pumping averaged approximately 1,000 kwhr per million gallons pumped. At 8,000,000 gpd, the pump's 24-hr rating, electrical energy cost at 1 cent per kwhr was $80. Thus, in 100 days of operation at full rating, this unit used power in an amount equal to its initial cost. A little calculation will show that only a moderate reduction in efficiency would make a less-efficient unit undesirable, perhaps even as a gift.

Efficiency, however, does not reside wholly within the pump. Wasteful loss of head in improperly designed piping networks may neutralize high efficiency in the pump. I have seen installations with as high as 990 deg of angularity in the suction and discharge piping, most of it in 90-deg bends. Because of manufacturing limitations, inlet and discharge connections of pumps are of sizes that produce a flow velocity higher than is desirable through any considerable



On 450 lbs. pressure.. 750° Temperature for over a year, *Yet*....



"Seat and Valve Could Pass for New, for all the Wear They Show"

(Reports famous Soapmaker)

Yarway's Stainless Steel, heat-treated valve and seat practically eliminate wear at the only point where wear could occur.

This valve is the only moving part in the Yarway Impulse Trap. There are no levers, pins, cotters or buckets — no pressure affected floats, diaphragms or bellows. The same valve seat is good for all pressures without change.

There are no castings used in Yarway Impulse Traps. They are built of solid bar-stock throughout. Body of cold-rolled steel (Stainless Steel for pressures over 400 lbs.) prevents distortion under pressure and is rugged to withstand accidental shock. Bright, rust-free cadmium finish inside and out.

These are the sound construction features — results of years of specialization, research and experience in steam engineering — that make Yarway Impulse Traps stand up in the most severe service.

Try this revolutionary Steam Trap. Its small size *saves space.* Its light weight *simplifies installation.* Its capacity and continuous operation *provide quicker heating* and *greater sustained heating efficiency.* Its *low price* usually makes it easier and cheaper to install a Yarway than to repair most old traps. You will like it.

Ask your Mill Supply House, or write for Bulletin T-1722. Sent on request.

YARNALL-WARING COMPANY, 100 Mermaid Avenue, Philadelphia

The Steam Trap Everyone is Talking About

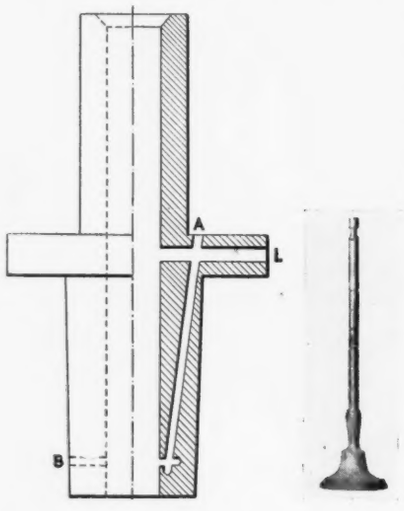
YARWAY

IMPULSE STEAM TRAP

length of pipe, on account of excessive loss of head. Pipe sizes should therefore be increased as closely as possible to the suction and discharge nozzles of the pump to secure proper flow velocity.

In new installations, the matter of loss of head in the pumping-station piping layout should be given the most careful consideration, for it is a continuous loss. Again, the simplest and most direct layout is almost certain to be the cheapest in first cost as well as in operating cost. The figure shows a layout designed to eliminate all possible bends that produce loss of head. It necessitates setting the pumps at 45 deg with the building, a departure which may appear radical, but which is entirely practical.

Council Bluffs, Iowa T E STUART



Lubrication Change Improves Valve Wear

A BATTERY of vertical internal-combustion engines, working under a constant 10% overload on 24-hr, 7-day service, gave excellent results except for frequent renewals of exhaust valves, seats and guides. The same type of guide was used on both exhaust and inlet valves. On the latter, they gave no trouble and required no attention except at the annual overhaul. Exhaust valves, on the other hand, had to be replaced after approximately 700 hours of service.

Lubricant, normally fed through the horizontal hole *L*, shown in the drawing, was not reaching the lower half of the guided section of the stem. Carbon built up at the oil-hole level and in the three oil grooves in the stem below that point, making miniature hones to cut away the guide bore. As service continued, this wear permitted more and more of the hot, corrosive exhaust gas to enter the clearance between valve stem and guide. Thus still further accelerating wear, until the valve failed to return truly to its seat, permitting high-temperature gas to blow by and cut the valve stem.

A set of replaceable valve-stem guides were modified by drilling a $\frac{1}{8}$-in. hole *A* from the spring seat downward into the tapered section to within 0.5 in. of the bottom. Intersecting this hole, a second hole *B* was drilled to permit oil to reach the valve stem almost at the bottom of its fit within the guide.

Now, even with normal tolerances as assembled, there is slight clearance between stem and guide. Pressure is always upward along the stem toward atmosphere outside the engine. Oil delivered to the bottom of the stem is therefore carried upward and distributed over the entire working surface, reaching and cooling that section subjected to the highest temperatures.

Where formerly valves and guides had shown 0.008-in. wear or more within a month after being installed, it now takes 6 to 12 months for that amount of wear to show up. The upper end of hole *A* was tapped and plugged at its spring-seat end, and any carbon deposition formed therein can be cleared simply by removing the plug and redrilling with a drill that will just fit the hole.

Longview, Texas M T PATE

Cleans Heater Tubes With Wire Rope

CLEANING heat-exchanger tubes, particulary on fuel-oil heaters used to heat Bunker C fuel, is a difficult task in many installations, due to cramped quarters and insufficient room to rod the tubes. Even with sufficient room, it is sometimes difficult to get the tubes clean.

On a recent visit to a boiler plant, the operating engineer was observed cleaning the tubes of the fuel-oil secondary heaters with a length of wire rope. He selected a rope of a diameter that would just fit inside of the tube easily and had frayed the rope end to provide sharp points. The spiral strands of the rope assisted materially in scouring inside surfaces of the tubes.

This flexible rodding device enables tubes to be cleaned easily and thoroughly where space at the ends of the heater is at a premium. The operator can perform the whole operation within a foot or two of the heater end, and the work can be done with a minimum of oil and mess on the floor.

Boston, Mass. J W REYNOLDS

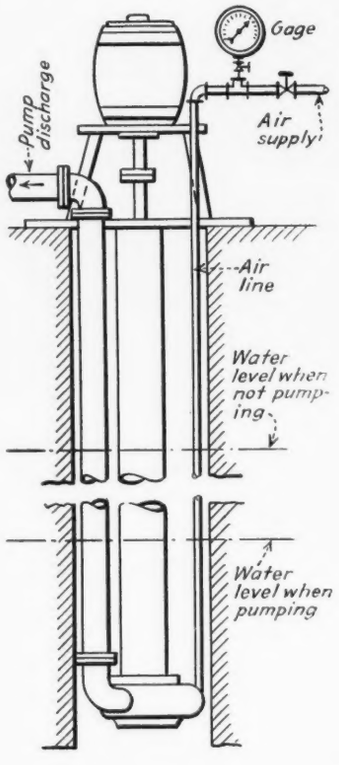
Finding Deepwell Water Level

DEEPWELLS as a source of water supply for industrial plants are becoming more common and add new problems for the plant maintenance crew. A frequent question is how can we tell when the efficiency of a deepwell pump is falling off, indicating needed maintenance. This is usually answered by comparing present efficiency with test efficiencies shown by the pump manufacturer's characteristic curves. Present efficiency is found with the formula:

$$\text{Efficiency} = \frac{\text{gpm} \times \text{head in ft}}{3{,}960}$$

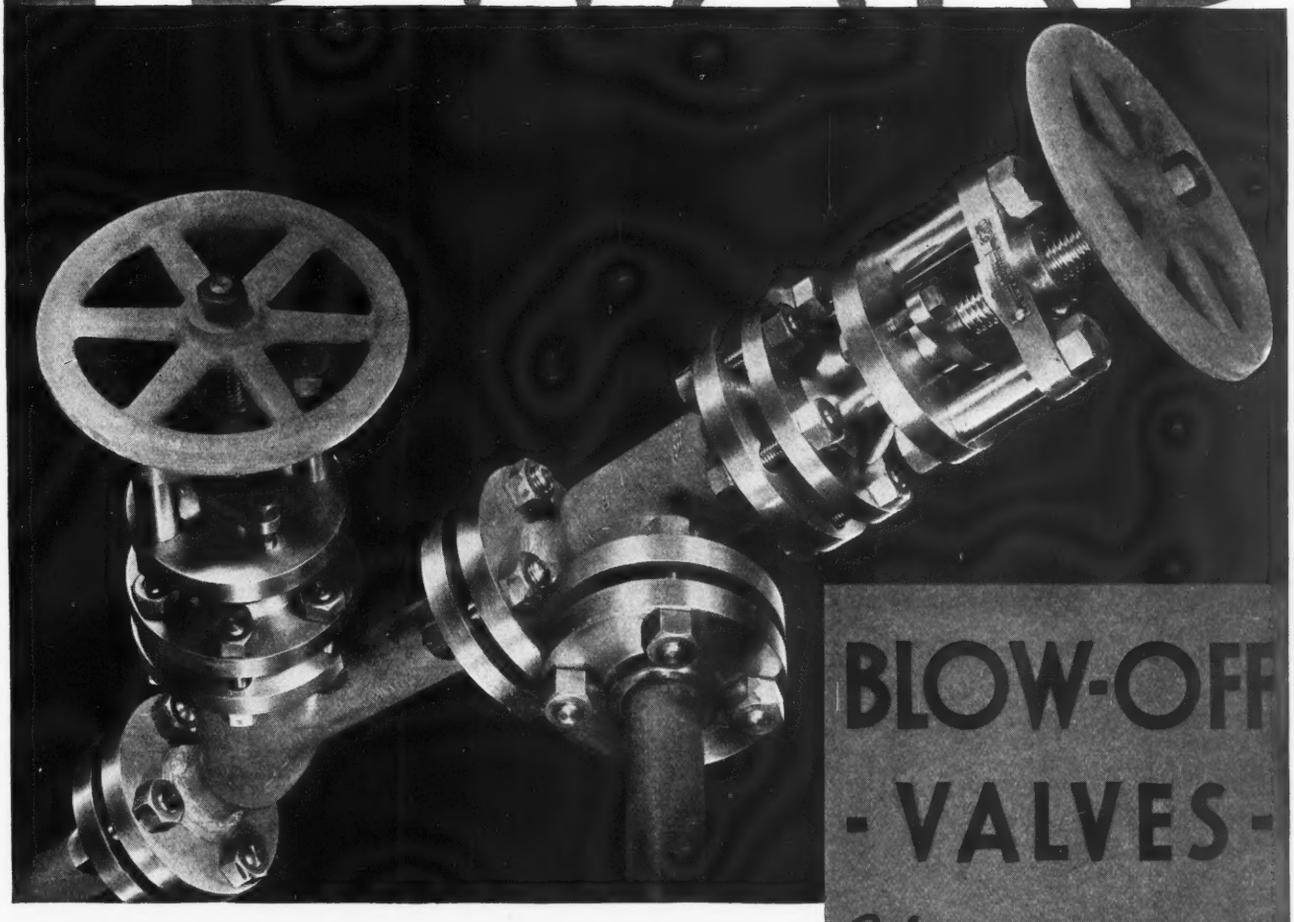
divided by hp input from pump-driving medium.

Gpm can be determined with a flowmeter, displacement meter or weir. Head in ft, however, is another problem. This head is equal to the pressure-gage reading at the ground surface divided by 0.434 plus the distance in ft from the ground surface to the water level in the well when pumping. As this level is usually variable, some method of accurate determination must be used.



A simple method of finding this distance is shown in the figure. A small pipe is dropped into the well to the centerline of the pump. This pipe is measured and its length recorded for future reference. A pressure gage and valve is placed in the line and connected to a compressed-air supply. The valve is partly opened to

EDWARD



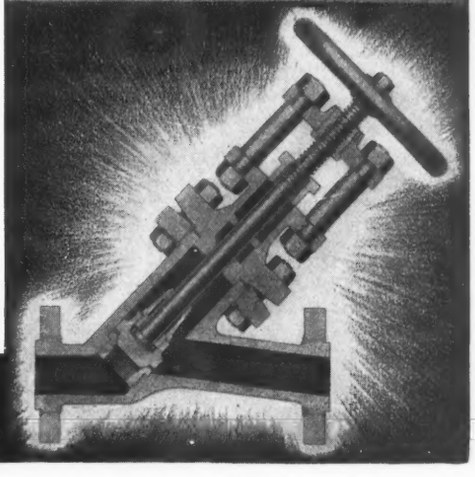
BLOW-OFF -VALVES-

You can always rely on them

YEARS of study lie behind the new Edward blow-off valves. Enduringly dependable, they cover the whole field from 150 lb to 1500 lb steam service pressure. Sturdy and tight, notably devoid of frills, they have the sound value of a product outstandingly suited to its special job. Built in straightway and angle types, they may be used in any desired combination or position.

Bodies and bonnets are of pedigreed forged steel for 400-600 lb and 900-1500 lb series . . . special carbon cast steel for steam pressures up to 300 pounds . . . Edward Ferac metal for steam service under 250 pounds. All seats, disks and stems are of EValloy, the wonder valve trim.

Specify them for main blow down and for water wall drains on new boilers. Choose them to end costly maintenance of worn valves on old boilers.



The Edward Valve & Manufacturing Co., Inc.
EAST CHICAGO INDIANA

admit air to the pipe. Air pressure indicated on the gage will be equal to the resistance offered by the submerged section of the line. Head of water above the pump can be easily determined by dividing gage pressure by 0.434. Subtracting this result from the measured length of the airline in the well will give the distance between the well-water level and the ground surface. It is advisable to make measurements when the pump is at rest and when running.

Friction loss in the section of pump-discharge line in the well must also be taken into consideration. This can be calculated with reasonable accuracy from head-loss tables in any engineering handbook, and the result added to previous total head calculations.

Roanoke, Va. S H COLEMAN

Manhole Gasket Caused Boiler-Tube Failure

TUBE FAILURES in watertube boilers are almost always caused by overheating. A recent tube failure emphasizes the need of using proper gasket material in watertube boilers. Soft rubber was used for a manhole gasket in a 250-lb boiler. After about two weeks' operation, a tube exposed to radiant heat of the fire ruptured under pressure. Considerable damage resulted to boiler-room fixtures and paint, and one man was seriously burned.

Investigation showed that the manhole gasket had become swollen, and large sections of it had broken away. One large piece was carried through the box header with the water and lodged at the rear end of a tube in the bottom row. As this was the water-entrance end, circulation was restricted through this tube, and overheating and failure soon resulted.

All manhole and handhole gaskets should be selected carefully, after ascertaining that the manufacturer's specifications conform to the desired service.

Cleveland, O. A G WIGGINS

Uses Welding to Reinforce Swamp-Stick

A SHORT PIECE of pipe is the universal extension applied by plant engineers when a wrench handle doesn't give sufficient leverage. Such short lengths of pipe have been responsible for many accidents through failure, or by sharp edges at the end which sometimes cut the hand.

One engineer, noting the condition of the swamp-sticks at his plant, gathered up the old pipes, some pulled

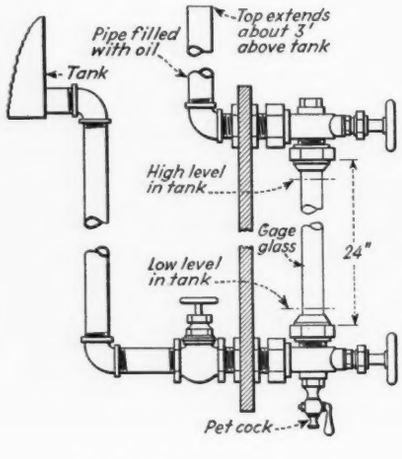
pear-shaped, others split along the weld at the end as at *A* in the figure, and discarded them in favor of similar pieces of pipe improved by a substantial bead welded around each end as at *B*.

The metal added by welding gives one end of the pipe sufficient strength to maintain its shape under load. The bead on the other end affords a satisfactory stop for the workman's hands, preventing possible injury or a fall.

Longview, Texas ELTON STERRETT

Simple Distant Water-Level Gage

WHEN it became necessary to know at all times the water level in a tank hidden from view and high above the floor, we made the simple gage shown in the figure. Variation between high and low level in the tank was only 20 in., so we used a gage glass 24 in. long with its required fittings. This



glass we mounted on a board in a vertical position where it could be seen easily, and piped its bottom connection to the bottom of the tank. From the top connection we extended a pipe vertically to about 3 ft above the tank and left top end of the pipe open.

To put the gage in service, with the tank full, the valve between the two was opened and water allowed to find its level in the pipe above the gage glass. Oil was then poured into the open end of the pipe until the water level showed at the top of the glass. This point was then marked *High*. The tank was then drained to what was to be low level and the point where the oil joined the water was marked *Low*. The intermediate points were then located by calculation and marked off. Because of the difference in density between oil and water, a change of 1 in. in water level in the tank caused about 1.25-in. change in gage level.

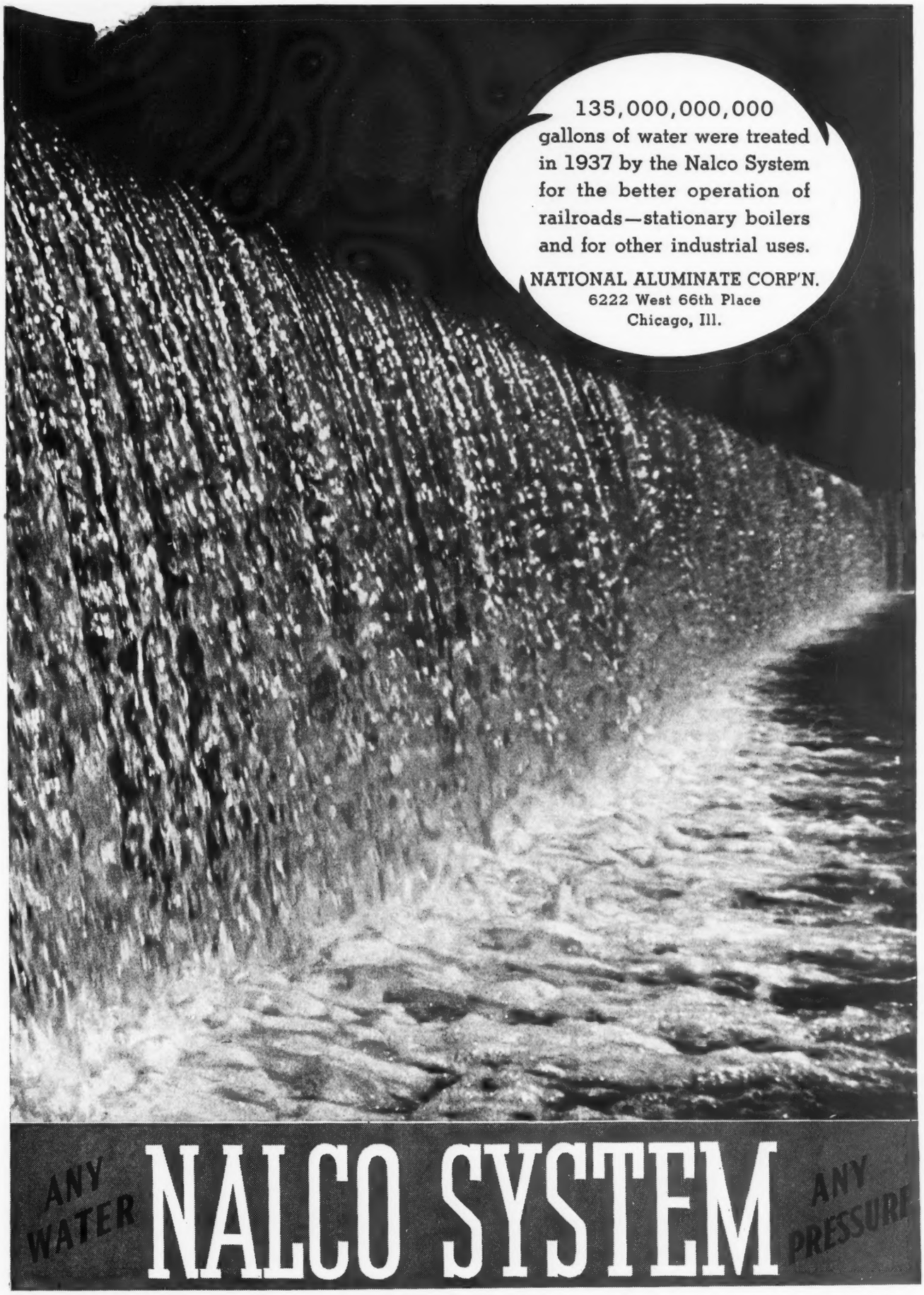
A pet cock was provided at the bottom of the gage glass so that it could be drained and washed out with gasoline. We pasted a strip of white adhesive tape on the back side of the glass to help in distinguishing the dividing line between water and oil.

Poughkeepsie, N. Y. ROY A CLARK, JR

Eliminating Cold Blasts From Unit Heaters

OF THE many complaints I have investigated during many years of heating-system maintenance, cold blasts from unit heaters are the most common. The cold blast is caused primarily by a drop in steam volume supplied to the heating system. In one factory where a large number of unit heaters were used, cold-blast complaints came in at the noon hour, following blowing of the 12-o'clock whistle. This trouble was caused by sudden dropping of the power load to a point where the exhaust steam turned into the heating system fell below the required supply.

Air moving out of a unit heater during cold months must be around 115 to 120 F to avoid a chilling effect. Obviously, even with the best of care in holding steam pressure constant in heating lines, there are going to be times when heaters will be deprived of steam and cold air will come from the fan. The room thermostat will not cure this trouble, as it only functions between certain predetermined limits and some time must elapse before room temperature would drop sufficiently to cause the thermostat to close down the fan motor. This condition can be controlled



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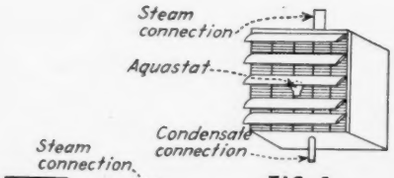


FIG. 1

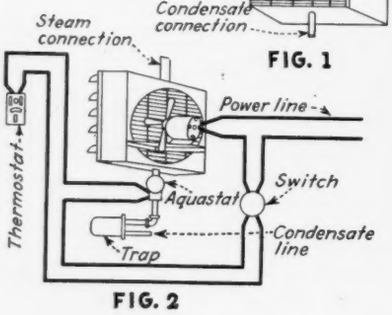


FIG. 2

and supervised by the addition of a second thermostat, sometimes called an aquastat, connected in series with the regular thermostat. The aquestat is applied to the face of the unit heater or to the surface of the steam line serving the unit heater.

Fig. 1 shows the aquastat applied to the face of the unit heater where air from the fan must flow over the section of bimetal of the aquastat. As long as steam is on and the heater is throwing out warm air, the aquastat-controlled circuit is closed; but as soon as the fan begins to recirculate air at room temperature, the circuit is broken by the aquastat.

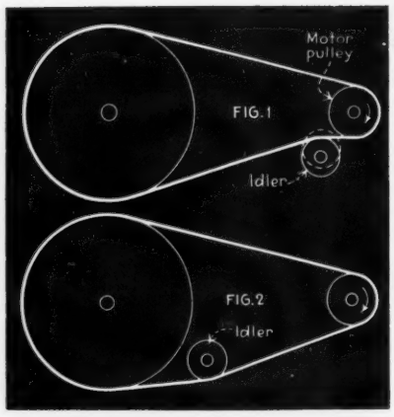
Fig. 2 shows the aquastat attached to the steam pipe instead of to the face of the unit heater. The aquastat is fixed to the pipe above the trap and as close to the unit heater base as possible. This avoids blocking of the unit-heater face, although the position of the aquastat directly in the center of air flow from the fan does not decrease the capacity of the heater to any perceptible degree. It does, however, interfere with the operation of the louvers in some installations. Being located on the face of the heater, the fan drives dirt and dust into the instrument housing and makes necessary periodic cleaning.

Philadelphia, Pa. C C HERMAN

Increasing Vee-Belt Life

ON A CALENDER, the vee-belt drive was originally equipped with a tightener pulley, see Fig. 1, to take up slack and further increase wrap of the belts around the motor pulley. Average belt life was less than four months. On investigation it was at once apparent that the 5-in. tightener pulley put a severe reverse bend on a 2½ in. radius in the belts. This bend ranged from an initial 28 to a final 47 deg when the idler had reached a position approximating the dotted outline.

Examination of discarded belts



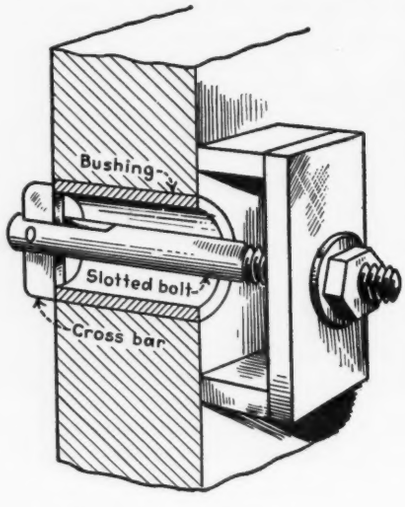
showed that outer plies had broken transversely at the bottom of the vee. The rubber on the upper or normal outside of the belt had been crushed until it was no longer able to hold the belt firmly in the sheave grooves. This trouble was corrected by locating the tightener as in Fig. 2, and replacing the original flat pulley with one grooved to fit the belts. With no other change in the drive, belt life increased to 22 months. Other sets passed the 2-year mark before wear impaired accurate speed regulation.

Longview, Texas ELTON STERRETT

A Simple Device for Removing Bushings

OFTEN it is necessary to remove a bushing or sleeve from some piece of machinery where it is impossible to drive the bushing out or use the common type of bushing extractor. A slotted bolt with a pivoted cross member of the correct width is the answer, as shown in the figure. It is inserted from the accessible end of the machine and the cross bar opened, as the gadget is made with a loose fit in the slot and on the pin. After attaching the regular strong back and distance pieces, the nut is tightened and the bushing easily drawn out.

Penacook, N. H. C H WILLEY

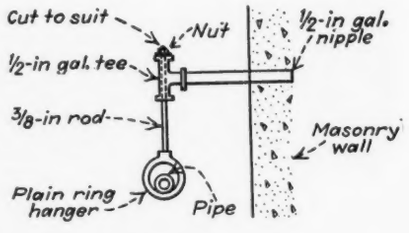


Blo… for Sa…

OPERATING personne… sider the popping pressure as the only safety-valve adjustment worthy of attention. The blowback, which is the number of pounds pressure drop from popping pressure to pressure at which the safety valve closes, is of considerable importance to economical plant operation. This adjustment is made by a ring, notched on its outer circumference and adjusted by a screwdriver.

Too great a blowdown results in an unnecessary loss of steam. Too little blowdown results in too frequent popping of the safety valve and unnecessary wear on the valve. The ASME Power Boiler Code specifies in P272—"a blowdown of not more than 4% of the set pressure, the blowdown to be in no case less than 2 lb." For a 100-lb safety valve, 3 to 4 lb blowdown is good practice. For a 200-lb valve, 4 to 6 lb is satisfactory; for 400-lb, 8 to 10 lb blowdown; and for 600-lb valves, 12 to 15 lb blowdown is preferable.

Columbus, O. J R WILLIAMS

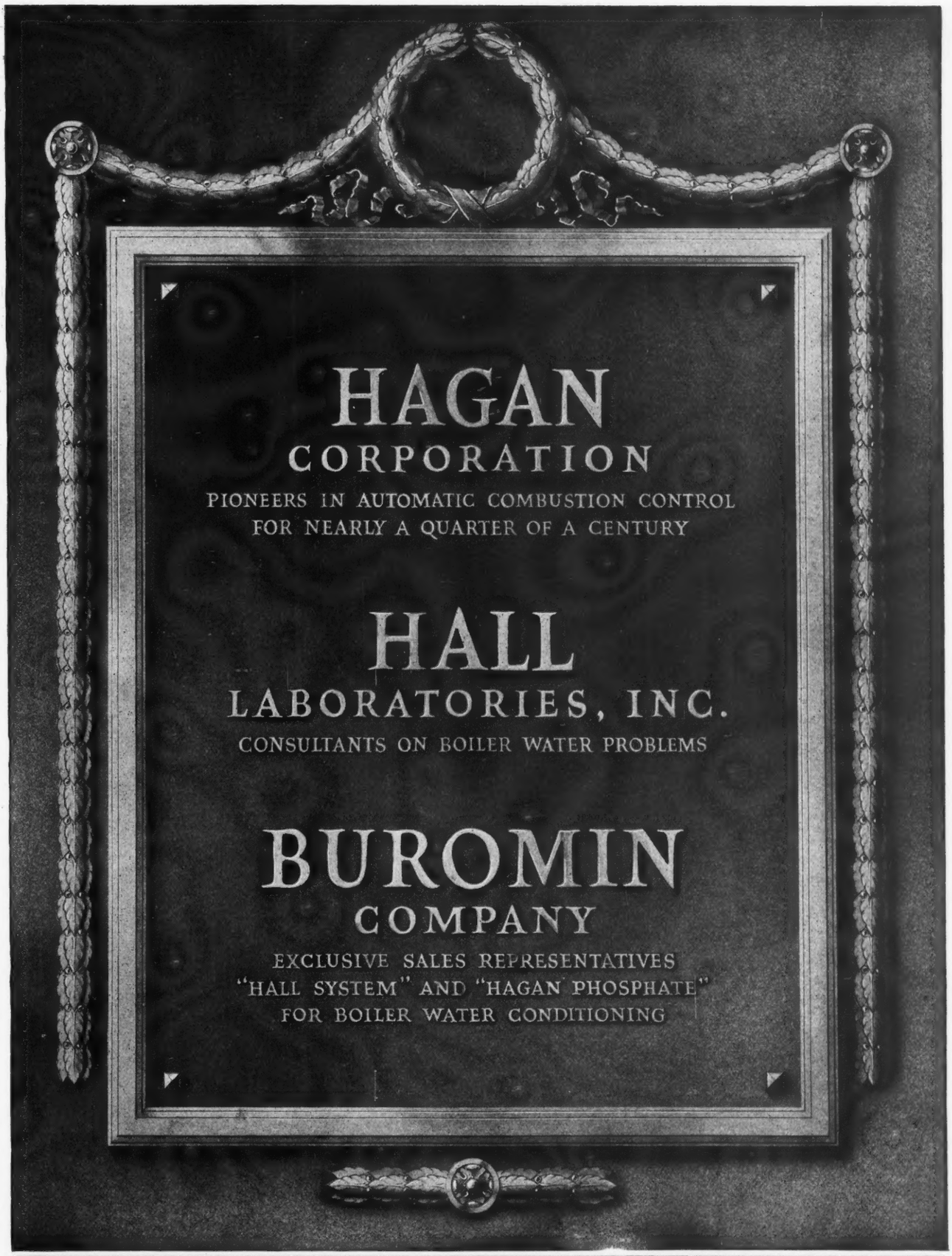


Easily Made Pipe Hanger

THE DIAGRAM shows a little piping kink used in the installation of heating and other small piping in our new water-softening building. Because of high ceilings from which the piping could not be conveniently supported, wall supports were used of the design shown. Each support comprises a ½-in. galvanized nipple and a tee. Holes were drilled in the wall for these supports, which were cemented into place.

The pipe is carried in rings with a threaded connection for a ⅜-in. rod. At their top ends, the rods are threaded to carry the pipe by a washer and nut from the top of the tee. These pipe supports are easily made from materials on hand and provide a cheap adjustable hanger.

Hibbings, Minn. ABE BENESOVITZ
Water, Light, Power & Bldg Commission



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CURRENT COMMENT

More About New York Diesel Plants

(To Philip Swain, Editor of *Power*)

UNDER the heading "Current Comment", in the December, 1937, issue of *'Power'* there appears a statement regarding diesel plants in New York by Huxley Madeheim. This called attention to a recent advertisement carried in the (New York) newspapers covering the discontinuance of the 600-hp diesel generating plant which was installed on March 8, 1937, by Sailors' Snug Harbor, and the securement of necessary electrical requirements thereafter through purchase from the Consolidated Edison Co of New York, Inc.

Mr. Madeheim raises the question as to a cash consideration in this transaction. In order that this point may be cleared up, may I please take advantage of the medium of your magazine to advise that no payment was made by the Consolidated Edison Co of New York, Inc, in this transaction, and that the only cash consideration which was involved was that of savings and economy which was secured to Sailors' Snug Harbor through discontinuance of operation of the plant in favor of central-station service. Convincingly and thoroughly outlining the entire situation is the statement of Mr. R Dudley, president of the Curtis Electric Corp, which is as follows:

> "Our Diesel plant has been in operation since March 8, 1937. Mechanically and electrically, the results have been very satisfactory. However, the new rate schedule which you put into effect this year results in our being able to replace the plant with your service with a saving in the operating cost large enough to justify closing it down."

Without going further into the self-serving statements of one who is principally financially interested in the installation of private generating plants, should not the determination of the economy of private plant versus utility service give consideration and importance not only to existing conditions, but also to conditions which can reasonably be expected to develop; particularly so in view of the history of the constantly rising costs attendant to private plant operation as against the constantly decreasing cost of Central Station service.

New York, N. Y. E F JAFFE
Vice-president, Consolidated Edison Co of N. Y., Inc

Additional Errors in November "What's Wrong"

FURTHER errors in "What's Wrong with this Picture—XXI", November, 1937, *Power*, are as follows:

1. Safety valve shown has same size outlet as inlet. The outlet connection is usually made larger because steam at low pressure has greater volume. The opening must be large enough so that the relieving capacity of the valve is not reduced by backpressure at the outlet.

2. Safety valve should be placed as close to the boiler as possible, and in no event should the distance exceed the face-to-face dimension of the corresponding tee fitting (American Standard).

Buffalo, N. Y. JOHN J TIMMONS

Why Preheat Before Babbitting?

REFERRING to the letter by M T Pate under the above heading, page 116, December *Power*, I am reminded of a babbitting experience with the late O N Trooien many years ago. Mr. Trooien's name is probably familiar to many readers of *Power*, as he was the author of, "A Steam Engine Investigation", which was published in Kent's *Mechanical Engineering Handbook*.

Mr. Trooien and I, both comparative youngsters at that time, were babbitting a box which we did not preheat. Unfortunately for us, there was some moisture present in the box which was converted into steam by the hot babbitt, and as a result, one of my eyes received a dose of the molten metal. Consequently, I went around with a bandaged eye for a couple of weeks. Ever since then I have carefully preheated all boxes before babbitting.

M M GOOCH
Atlantic Highland, N. J.

Rebabbitting Compressor Main Bearing

THE ANSWERS to the question on how to babbitt a main bearing in December *Power* interested me, but it is my opinion that AGH cannot hope to successfully rebabbitt the main bearing of the ammonia compressor with the shells in position. That the shells cannot be removed endwise is not uncommon and has no point. Unless he has proper equipment for melting the babbitt, heating the bearing shells and mandrel as well as boring the bearing after peening it, he can save a lot of grief by sending the shells to a properly equipped shop and having the work done.

The first step after removing the shells is to melt out the old babbitt. The top sh ll as a rule is not subject to wear and will not have to be rebabbitted. In melting out the old babbitt, all oil will be burned off the shells. The shells must be wire brushed to remove any carbonized oil and get a good bond, especially if the babbitt is not dovetailed into the shells.

For an 8-in. bearing, I would use a piece of 7-in. oil-well drive pipe as a mandrel. This would give an outside diameter of about 7.5 in. after the pipe has been smoothed up in a lathe. Pouring the shells to this smaller diameter will enable him to peen the babbitt well and then bore the bearings to the proper diameter. Each shell should be poured individually and the shell and mandrel well heated to insure a smooth pour.

Set the mandrel vertically on a level steel surface and line the shell to it, maintaining proper distance from the mandrel by two $\frac{1}{8}$-in. steel plates clamped to the flats of the shell. Clamp the shell and mandrel securely together and seal with putty where the edges of the steel plate touch the mandrel, to prevent the babbit from running out. Make a ridge of putty around the top of the shell in order to overfill the shell.

Melt enough babbitt to allow for leaks. Use a wide spouted ladle for pouring to have a wide stream of babbitt running into the shell. Make a continuous pour until the shell is filled and then there will be no cracks or separations. When all the shells have been babbitted, peen the entire surface of the babbitt with a ball-peen hammer. This tends to make a firmer and more compact mass of metal. It is better to go over them two or three times with a light tapping blow rather than just once with a heavy blow of the hammer.

With the inside dimension of the pillow block found, set up the shells so that they can be bored to the proper diameter. If extreme care is taken in the setup and boring, a minimum of scraping will be necessary to insure a good bearing on the shaft. If dimensions are watched closely, it will only be necessary to scrape for clearance at the edges of the shells, giving about $\frac{1}{16}$-in. clearance at the edge, tapering to nothing about 1 in. from the edge toward the center of the bearing on an 8-in. box.

Dorchester, Mass. W F O'REGAN

AGH NEED have no worry regarding pouring hot babbitt on a cold shaft 8 in. in diameter when rebabbitting a compressor bearing. Polish the shaft with fine emery cloth and have it free from oil or other substances which might produce gas when heated, as this will cause holes to form in the babbitt.

If the quarters of the bearing shell permit, one side quarter and the bottom quarter may be babbitted at the same time with a cardboard separator between them, by slipping them under the shaft to cover the bottom 180 deg. Then roll the quarters out, separate and replace them in their normal positions. Place the second side quarter in its normal position with a cardboard between it and the bottom quarter. A second cardboard may be used at the top side backed up with asbestos putty, leaving a small aperture through which to pour the babbitt. When the babbitt has been poured, roll the quarter out, trim and

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replace, minus the cardboard. The top quarter may now be placed on the shaft, using separators between it and the two side quarters, and this time pour the babbitt through a hole in the shell. Liners will have to be used under the top-quarter sides when the bearing is finally reassembled.

Asbestos putty or asbestos rope may be used to retain the babbitt at the ends of the bearing quarters. Presumably the collar shrunk on the shaft is used as a thrust; therefore, the babbitt should extend along the shaft to the collar.

Little Fort, B. C. G B THOMPSON

Compressed Air for Soot Blowing

FOR MORE than 15 years, compressed air has been used in one plant that I know of for blowing the tubes of water-tube boilers with no injurious effect. Aside from the experience of this plant, I see no reason why air should damage the tubes. It seems to me that air is the logical thing for all low-pressure boilers.

In Question 2, October *Power*, EHR does not mention the operating pressure of his plant. If the steam pressure is over 50 lb and if the soot blowing is mechanical, then steam can be used. If the soot is blown by hand, because of the greater convenience in handling the blower, air is defendable although more costly.

In many plants soot is blown three times each day. If flue-gas temperature does not show any reduction after blowing the soot it means that the blowing is too frequent. In one plant, gas-fired boilers were blown every 8 hours, but tests showed that once per week was enough. In the plant mentioned in the preceding paragraph, where the soot blowing was by air, manually operated, the boilers were coal fired and a blowing performed once a week was found enough.

Chicago, Ill. N T PEF

More About Hot-Water Heaters

IN OCTOBER *Power*, Charles W Carter JR, asks why it would not be good logic to install a check valve in the feed line of a hot-water heater to prevent pressure in the heater from forcing hot water back into the cold-water mains with possible damage to a meter or injury to someone opening a cold-water faucet. I feel that a check valve in the feed line creates a number of hazards.

If a water hammer should develop from the sudden closure of a valve in the hot-water system, it would tend to close the check valve, allowing the full shock pressure to act on the heater instead of being dissipated in the cold-water system.

If the heater relief valve fails to operate, a check valve would prevent the overpressure from being dissipated in the cold-water system. Recent explosions of hot-water-storage tanks in residences have been attributed to a check valve in the cold-water system between the tank and the street main. Relief valves, while usually omitted on this type of installation, should always be provided, because even in the absence of a check valve, freezing or other obstruction in the cold-water system may create an explosive hazard.

Tanks heated with steam coils should always have shells of sufficient strength to withstand the maximum steam pressure that might occur in the coils. If this pressure is greater than the safe working pressure of the shell or piping system, a reducing valve should be installed in the steam line to the heater followed by a safety valve set at a point well below the maximum working pressure of the weakest section.

Properly maintained temperature-control devices, arranged to regulate steam flow so that a predetermined maximum temperature is maintained in the heater, are the best insurance against injuries from excessively hot water.

Roanoke, Va. S H COLEMAN

"No Problem Solved, No Education"

THE EDITOR of *Power* wrote a thought-provoking editorial in "Speaking of Power," October *Power*, in which he made a number of very pertinent criticisms of the present educational set-up. The gist was that education in general had not, for operating engineers, been placed on a basis which is sufficiently practical to be of any great value. He made a particular effective comment to the effect that you cannot learn engineering by listening to lectures and went on to say "No problem solved, no education. . . ."

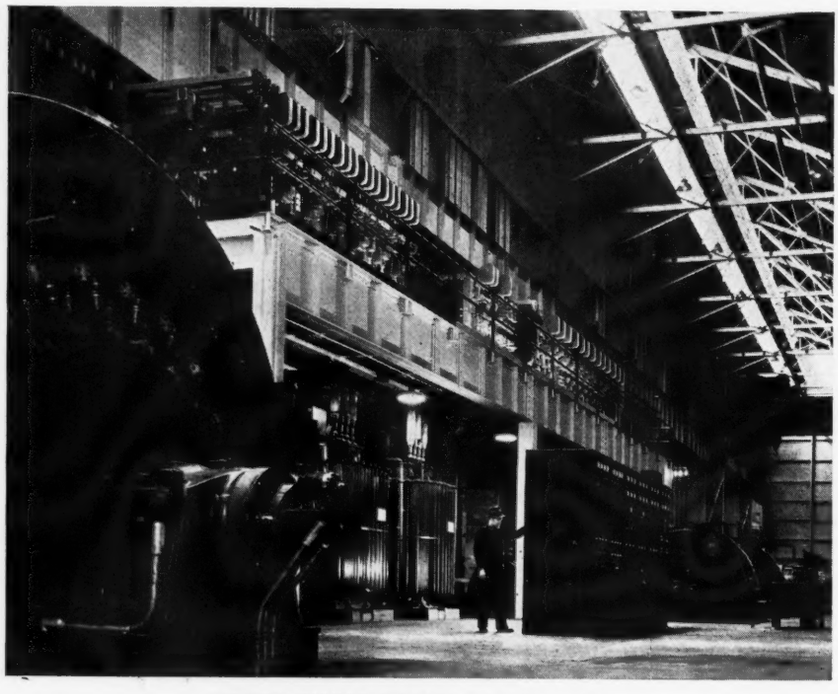
The result of this editorial stimulated the writer to comment upon a number of educational practices now in use at the Rochester Athenaeum and Mechanics Institute. In the first place, education is an individual matter and if one accepts this hypothesis, lectures as such are pretty much out of the picture. Furthermore, problems of various kinds must be solved by individuals in the engineering field since, after all, that is really the sum and substance of engineering.

If lectures are of such vital importance, then they should be written and handed out to students so that everyone will have a complete copy, not just fragmentary notes taken in class. If the materials to be presented in lectures are well organized, the student should have the complete lecture handed to him in written form for the purpose of study and reference.

In the Institute's evening division teachers (let's not call them professors) come from industry itself. In the day school, staff members serve each summer in one of the Rochester industries. These two procedures bring to the classes a wealth of practical experience that is at the same time tied up with fundamental principles underlying engineering and production problems.

The Institute has within the last few years abandoned the obsolete but overworked theory that a person should receive a diploma because he has spent a given number of hours sitting in classes. In place of this, students are granted diplomas upon a basis of competence regardless of the time spent in becoming competent.

Rochester, N. Y. MARK ELLINGSON
President, Rochester Athenaeum & Mechanics Institute

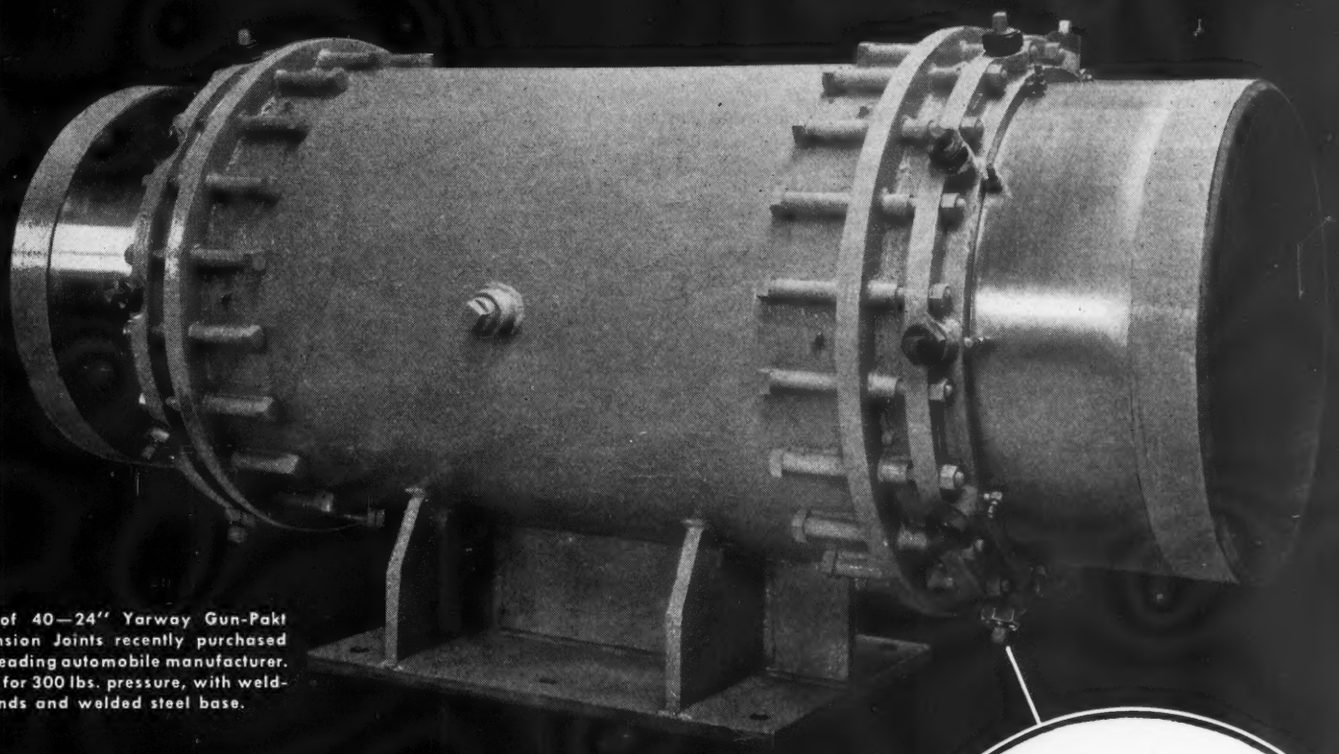


SEALED MOTOR ROOM FOR STEEL MILL

Motor room of the new Jones & Laughlin Steel Corp's 96-in. continuous-strip steel mill, housing 12 giant motors capable of developing a total of 45,000 hp. These motors drive scale breakers, roughing and finishing stand of the hot mill. The entire motor room is sealed with welded steel, plated to height of 12 ft above floor level

YARWAY

GUN-PAKT EXPANSION JOINTS



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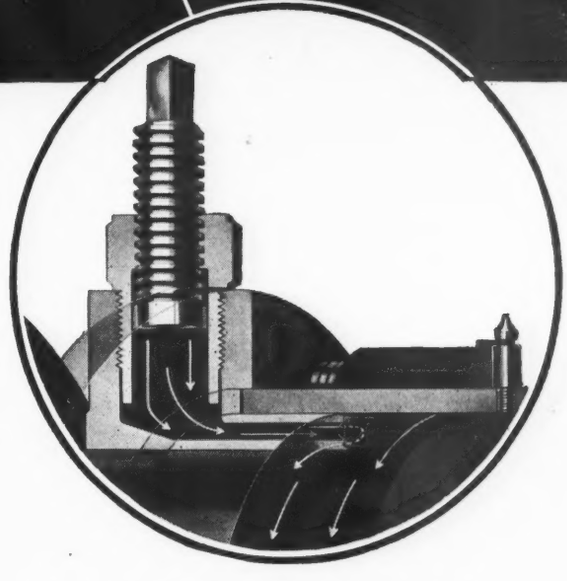

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READERS' PROBLEMS

QUESTIONS for Our Readers

Copper Chloride for Soot Removal

Question 1

I HAVE *been informed that copper chloride is used to clean soot from boilers and furnaces. I would like some information on this subject, particularly in connection with method of application and whether or not it has any harmful effect on the boiler. Also, is it copper chloride with or without water of crystallization.*—KG

Cleaning Oil-Cooler Tubes

Question 2

OUR 4,000-KVA *turbines are fitted with oil coolers made up of a bank of tubes in a cylindrical casing. Water flows through the tubes, and oil is caused to cross the outside of the tubes many times by diaphragm baffles. The staggered layout of the tubes makes it impossible to obtain access to the inner tubes for cleaning, and in the course of time all but a narrow path in the center has become clogged. We have tried boiling a mixture of soda ash and trisodium phosphate in them for a fortnight, and other obvious schemes, but short of dismantling the tube stack (which is a sweated job) have not found a satisfactory solution.*—TDO

Suitable answers from readers will be paid for if space is available for publication.

SIMPLE TRAP TEST

Answers to Nov Question 1

The Question

WE HAVE *been looking for years for a simple method of testing thermostatic steam traps without removing them from the line. When a trap is suspected of blowing steam, we would like to be able to check it without going to all the trouble of dismantling the line and putting the trap on a test rack. Perhaps some* POWER *readers have devised simple and sound ways of doing this. If they have, we'd like to know about such methods to simplify our present involved procedure.*—JES

Install Test Tee

IF A VALVE is placed in the discharge line from the trap and a tee with a valve on the side outlet is placed between the trap and the first valve, it is possible to test the trap in the line. Closing the valve in the discharge line, and opening the valve on the tee, will permit the trap to discharge to atmosphere. Observation will show whether the trap is blowing steam.

The temperature at which the thermostatic trap operates may be determined by inserting a tee in the discharge line close to the valve and placing a thermometer in it while the above testing is being carried out. If frequent tests are desired, the tee may be equipped with a thermometer well into which an ordinary glass-stem engineer's thermometer can be inserted when a reading is needed.

Lexington, Ky. I A BUTCHER

Test by Inspection

IF THERE is no discharge valve in the outlet connection of the trap or in locations where a freeblow test may not be practical—with radiator traps in offices, for instance—internal inspection can be used. Thermostatic traps will blow steam for several reasons: the needle valve may be worn, the thermostatic element may have sprung a leak, or a chip of dirt may be preventing the valve from closing. Inspection of the needle valve and seat is simple. The element can be tested by exposing it to a blast of steam and dipping it into cold water. Tight bellows will readily expand and contract.

For routine testing, the freeblow method is, of course, much simpler, and is used in our plant whenever conditions permit. However, the thermostatic traps in our office-heating system are inspected internally from time to time. An experienced man can usually tell the need for such inspection by feeling the temperature of the trap-discharge connection.

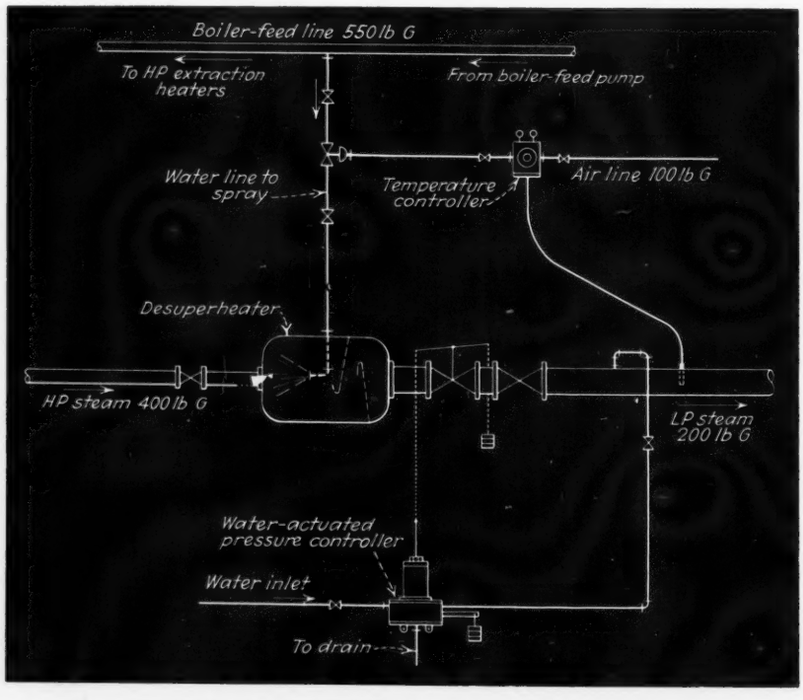
Using these methods and carrying a supply of bellows and valve seats on hand, we rarely find it necessary to remove any of our traps from the line for repairs. Leaking needle valves are replaced and then reconditioned in the shop at some convenient time, if their condition warrants it.

Old Bridge, N. J. A J LUBELEY

Test by Ear

THE SIMPLEST method of testing the action of a thermostatic trap is to listen for it by placing one end of a metal screwdriver, and wrench or similar object against the trap body, the ear being held at the other end. If the trap is blowing steam, the sound can be readily distinguished from the intermittent sound of condensate discharge, heard when the trap is working properly. With a little experience, it is easy to tell by this test just how a trap is functioning.

Frequently a particle of scale, pipe



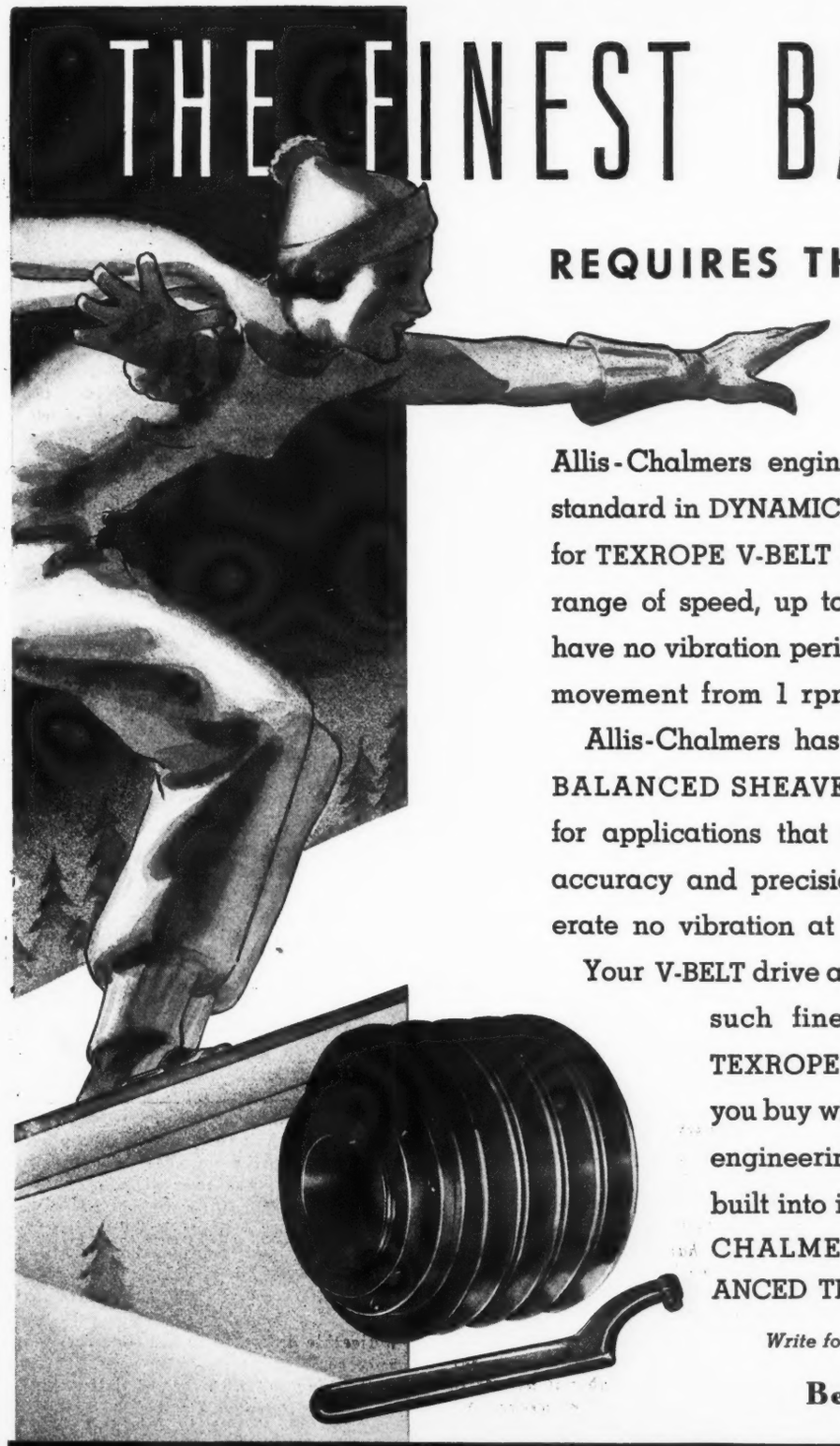
WHAT'S WRONG WITH THIS PICTURE?—XXIII

Reducing Valve and Desuperheater Installation

At least 12 errors are shown in this drawing. Make a list of those you recognize, then compare with the list on page 60

THE FINEST BALANCE

REQUIRES THE FINEST ENGINEERING



Allis-Chalmers engineers now set a new high standard in DYNAMICALLY BALANCING Sheaves for TEXROPE V-BELT DRIVES. Over their entire range of speed, up to 6,000 rpm. these sheaves have no vibration period . . . they run like a watch movement from 1 rpm. right up to 6,000 rpm.

Allis-Chalmers has made the DYNAMICALLY BALANCED SHEAVE commercially available for applications that require the most extreme accuracy and precision, and can therefore tolerate no vibration at any time or at any speed.

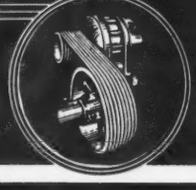
Your V-BELT drive applications may not require such fine balance, but whatever TEXROPE V-BELT DRIVE equipment you buy will have the same caliber of engineering ability and experience built into it, that produced the ALLIS-CHALMERS DYNAMICALLY BALANCED TEXROPE SHEAVE.

Write for Vari-Pitch Bulletin No. 1261-A

Belts by Goodrich

743

ALLIS·CHALMERS



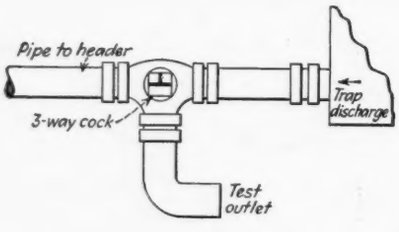
MILWAUKEE WISCONSIN

cutting, or other foreign material will lodge in the valve seat. Rapping the side of the trap body smartly with a piece of metal will sometimes restore the trap to normal operation. If not, the trouble is more serious and the valve should be closed off by valves provided for that purpose, or in a vacuum-heating system, by closing the inlet valve of the apparatus which the trap drains. The cap of the trap can then be removed, and the seat and element cleaned and thoroughly examined. This will nearly always disclose the source of trouble without the necessity of removing the trap from the line.

Oakland, Calif. T W BEAN

Install 3-Way Cock

TO CHECK our traps, we installed 3-way cocks in the pipe between the trap outlet and the discharge header, as shown. The outlet from the third way of the cock is visible, and to check a trap it is only necessary to set the cock so that

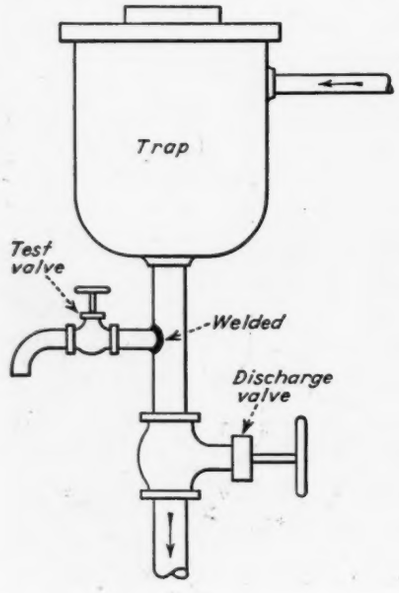


the discharge header is cut off. The trap is then as free as if it were on a test rack. All traps in the station have this device fitted and are checked daily.

Newcastle, England T D OSWALD

Weld Test Valve in Line

TO TEST traps, we install a discharge valve, if not already provided, weld a short nipple to the discharge line ahead of the valve, and screw a valve on the



other end. Valves from the junk pile may be used, and in the case of the test valve, an ordinary petcock may be used, as there is seldom any pressure in the discharge line. Closing the discharge valve and opening the test valve will show leakage.

Kansas City, Mo. CARL E DOUGHTY

WHAT'S WRONG WITH THIS PICTURE?—XXIII

Reducing Valve and Desuperheater Installation—See Page 59

1. *Desuperheater in wrong location.* Should be on low-pressure side of reducing valve to avoid incrustation of valve parts from scale-forming matter in the spray water. Also to avoid subjecting desuperheater shell to pressure higher than necessary.

2. *No standby pressure reducer.* Some means of maintaining pressure in the low-pressure line should be provided so that the reducing valve may be removed from service for repairs.

3. *No trap on desuperheater.* Sufficient trap capacity should be installed to prevent flooding should the water-control valve fail to function.

4. *Need pressure gage.* A recording gage on the low-pressure line affords a means of checking the accuracy of control.

5. *No relief valve on low-pressure line.* A relief valve is necessary to prevent excessive pressure due to failure of reducing valve.

6. *No free-blow valve on control piping.* A free-blow arrangement would permit occasional blowing of dirt from the control piping of the reducing-valve pressure controller.

7. *No strainer in inlet piping of pressure controller.* Strainer would prevent any dirt from clogging the pilot valve.

8. *Need reducing valve on inlet-air piping of temperature control.* Commercial temperature controllers usually operate at pressures below 40 lb. A reducing valve with a relief valve on the low-pressure side should be installed and set at the pressure recommended by the controller manufacturer.

9. *No filter in inlet-air line of temperature controller.* A filter is needed to remove moisture, dirt and oil from the incoming air. Foreign matter will cause trouble in the controller.

10. *No thermometer well in the low-pressure line.* A test thermometer adjacent to the sensitive element of the temperature controller affords a means of checking its accuracy.

11. *Need bypass around desuperheater water-control valve.* With a bypass and valve, the water flow can be controlled manually when the temperature controller or its valve is out of service.

12. *Spray-water line improperly connected to boiler-feed piping.* Should be connected on high-temperature side of extraction heaters so that a maximum of exhaust and extracted steam will be utilized.

Condenser Cleaning

Answers to Nov Question 2

WE HAVE *been using rubber plugs for condenser cleaning for many years and have been getting fair vacuum results and tubes last eight or nine years. Recently we have been trying a steel scraper plug which gets the tubes cleaner but seems to scratch the tubes. Do* POWER *readers know of anyone who has used these plugs long enough to be able to say how much oftener we will have to replace condenser tubes if we use the steel plugs every couple of weeks.*—MCC

Steel-Scraper Method Given Test

APPROXIMATELY 10 years ago, we were confronted with the same problem. We had been cleaning condensers with high-pressure jets of water, rubber plugs and brushes with fair results. The steel scraper plug seemed to have obvious advantages as a cleaner, but would affect the life of the tubes. In order to give some indication of the effect on tube life, one condenser tube was removed, the scraper plug run through repeatedly and the metal removed from the tube collected. This test showed that the quantity of metal being removed was negligible and would not be enough to affect the life of the tubes in ten years of ordinary service at our plants.

The scraper cleaner was then put in use on all condensers and has been used regularly up to the present time. It does scratch the tubes slightly, but it does an excellent job of cleaning and from our observations, there is no tendency for these tubes to foul any faster than those cleaned by other methods. Furthermore, there has been no change in the over-all life of the tubes as compared to periods prior to 1928. We have used the plugs about once every two months, but our experience to date would indicate that they could be used every two weeks for periods as long as 10 years with no noticeable difference in the time between tube replacements.

Washington, D. C. C E MILLER
Potomac Electric Power Co

Steel Scrapers Best for Hard Deposits

CLEANING condenser tubes with rubber plugs is quite satisfactory where the deposit is soft. However, if the deposit is hard, and sticks to the tubes, steel scraper plugs are necessary to do a good job. Steel scraper plugs not only remove the soft slime coating, but they scrape off harder scale deposit as well.

Cutting or scratching of the tube by the metal cleaner is found practically

(Continued on page 124)

BUELL
solves the Fly-Ash problem at this station

Full details of installation will be forwarded upon request

· BUELL ·
Fly-Ash Eliminators
(van Tongeren System)

BUELL ENGINEERING CO., INC. • 70 PINE ST. NEW YORK, N.Y.

ACE IN THE HOLE....

"MARK TWAIN IS DEAD!" screamed the newspaper headlines. They drew a mild protest from the humorist, who insisted, "The report of my death is grossly exaggerated." He was a master of understatement, a man who understood our national habit of talking the simplest happening into a miracle.

Advertising would be lost without the "greatest", "best", "biggest", "grandest", and the rest of the "est" words that are supposed to make us potential customers realize what a bandwagon we've just barely got a chance to get on before it gets away. We are made to feel that this feedwater treatment or that kind of pipe is just the thing we've been needing all these years, that this lubricant or that pump is the answer to all our silent prayers.

But an engineer's mind is full of question marks. The "est" words raise all those questions—sometimes to the point where we just don't believe any of the advertiser's story because a part of it is full of "ests".

An engineer deals with facts. Experience has taught him to doubt even what he sees. He likes to try everything himself. He's frank and open, so he's a lot more likely to believe the man who says, "This is a good lubricator," than the one who says, "This is the finest lubricator the world has ever seen." He may finally agree with the second story, but he wants to find out for himself. It is smart under those conditions to understate a little—actually to have something a little better than you claim it to be, so that it works out a bit better than it is expected to. That's a useful ace in the hole.

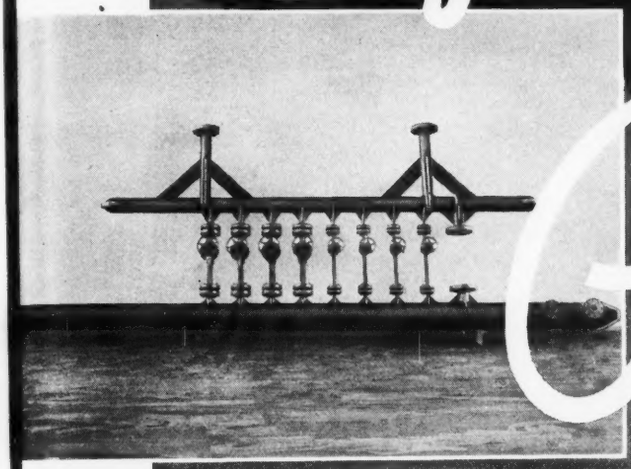
An old story illustrates my point. A Yankee driving in the deep South picked up an old Negro. Along a narrow mountain road, he overtook a goat, standing squarely in the middle of the road, with the mountain on one side and a rushing stream on the other. He turned inquiringly to the old Negro. Rastus suggested, "Boss, why not try honkin' at him?" The Yankee pressed hard on the horn button, frightening the goat so he jumped over the cliff and was drowned. He turned to the old Negro and said, "Your idea wasn't so hot, was it?"

"Lissen Boss," said the old darkie, "Youall pushed too hard. Was jest too much horn for that much goat!"

George Edwards

Engineer

Experienced Prefabrication

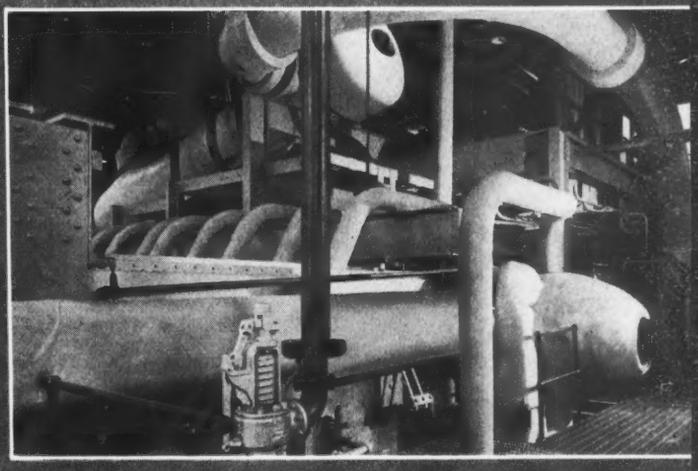


AND

Erection

OF

COMPLETE PIPING SYSTEMS



At Pittsburgh Piping competent engineers are equipped, because of their experience, to collaborate with design engineers and to execute the final plans efficiently and intelligently. Together with skilled machinists, pipe benders and licensed welders working under controlled shop conditions . . . able, trained erectors with the finest possible field equipment—all combine to offer unusual service for every type of piping system.

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Investigate!

An indispensable tool in hundreds of plants!

DEXTER GLOBE VALVE RESEATING MACHINE

Simple. Positive. Quick! Pays for itself over and over in a short time. With this machine you can reseat valves at the first sign of leak—without loss of water, steam, or other troubles.

Valves reseated in place

Save the cost of new valves. Also labor cost of replacements not to mention possible damages and lost time. Machines in valve capacities from ¼—3″ up to ¼—12″ inclusive.

Send for Catalog 24 describing above machine also DEXTER machines for reseating gate valves and pump valve seats.

(Also manufacturers of the Swendeman Automatic Separator)

THE LEAVITT MACHINE CO.

10 East River St. Orange, Mass.

Readers' Problems

(Continued from page 120)

negligible, depending on the hardness of the tube metal. The cutting edge of most cleaners does not bite into the tube metal. The cleaners should be examined each time they are shot through a tube to be sure there are no sharp corners that may cut the tubes It is generally impractical to try to remove the very last trace of scale and this scale has little effect on heat transfer, yet is considerable protection against cutting the tubes.

Occasionally metal cleaners will lodge in the tubes, and care should be taken to remove them. They may be pushed out with a rod or pipe. Where tubes are slightly necked at the end from setting the packing up too tight, it may be necessary to grind the cleaner slightly to prevent sticking. Metal cleaners vary in design; there are several good ones, the makers of which furnish specific instructions for their use.

If a few precautions are observed, including these mentioned, cleaning tubes with metal plugs is very satisfactory, and it is the writer's opinion that this type cleaner will not shorten the tube life to any extent.

Leavenworth, Kan. H CANTRELL

Satisfactory Performance With Homemade Cleaner

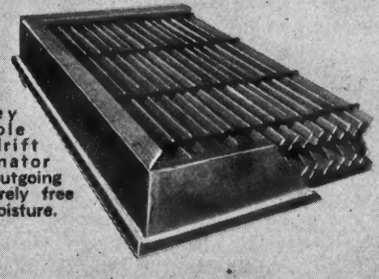
IF MCC will check up on the residue after running steel scraper plugs through his condenser tubes, he will probably learn that tube walls are being thinned seriously, both by the removal of actual metal by the scraper plugs, and by erosion and corrosion speeded up by the continued presentation of fresh surfaces for attack.

Rubber plugs are of value chiefly when the material to be cleaned from the tubes is soft and easily forced ahead of the plug. If of a harder nature, particles are apt to become imbedded in the rubber and it will then serve as matrix for the cutting particles, giving rise to the condition mentioned by MCC.

In the oil industry, heat exchangers are widely used in refineries, gasoline plants and pump stations, and the problem of exchanger tubes closely parallels that of the steam-plant condenser. One refinery from which records are available showed a 40% reduction in heat-exchanger-tube life when steel scrapers were used over that noted with plastic cleaning plugs. Useful life was determined by testing a tube to destruction at intervals under hydraulic pressure, twice that met in working conditions.

To obtain greater cleanliness than that obtainable with the plastic plug, a scraper modelled on the shotgun wad was devised, and after undergoing some improvements, regularly employed on all heat-exchanger-tube cleaning, being sent through ahead of a plastic plug or on its own, depending upon the degree of fouling to be removed.

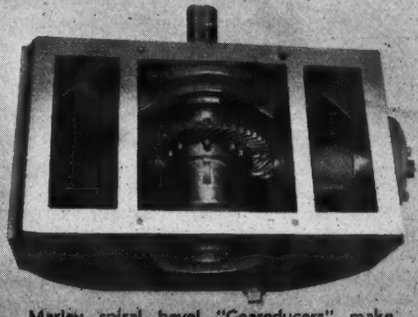
Nearly 300 Tests
Proved Their Superiority of Design and Performance



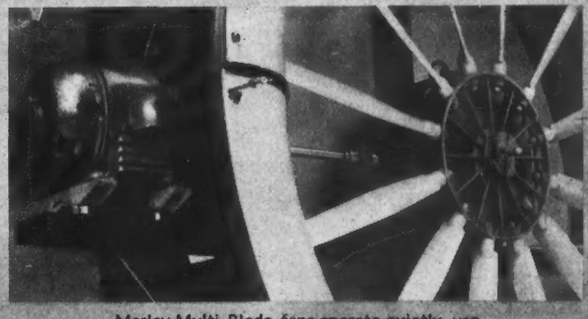
Marley multiple effect drift eliminator keeps outgoing air entirely free from moisture.

MARLEY forced draft design is the result of nearly 300 comparative tests, made under actual operating conditions. Proof of superior performance is in the records of these tests. Details upon request.

THE MARLEY COMPANY
1915 WALNUT KANSAS CITY, MO.

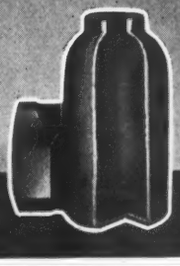


Marley spiral bevel "Geareducers" make many gear ratios available—are heavily oversized and precision built throughout.

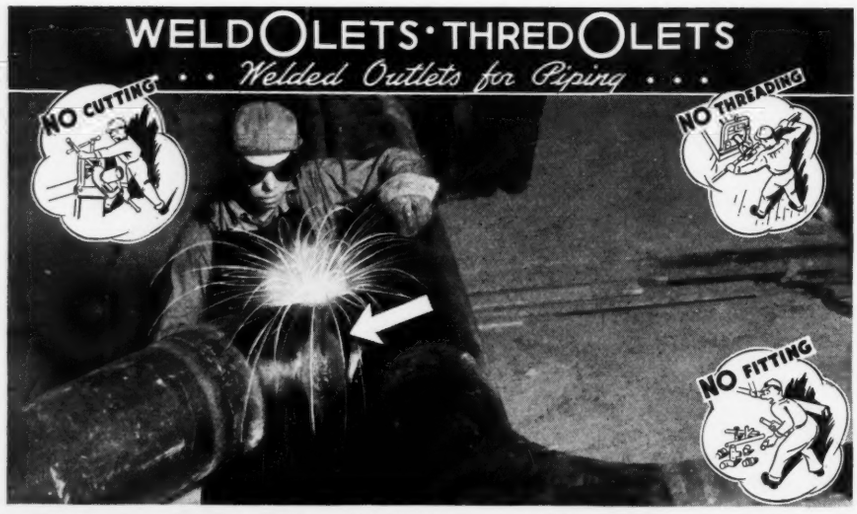


Marley Multi-Blade fans operate quietly, use less power. Note details of motor mounting, drive shaft, gear box and blade assembly.

MARLEY



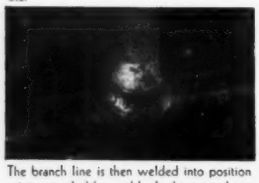
FORCED DRAFT COOLING TOWERS



WeldOlets and ThredOlets are easily installed. Simply select the position of the outlet, rub the fitting over the pipe several times to remove scale, mark center lines and tack the WeldOlet or ThredOlet into position.

The WeldOlet or ThredOlet is then welded into place either by the electric-arc or oxy-acetylene method. A junction of full pipe strength and an outlet that is leak-proof is the result.

Where the outlet is 2" or larger, it is recommended that the button be removed after the welding operation. On small sizes, the fitting is used as a templet and the hole is cut in the main pipe first. A full inspection of the inside of the joint is possible by using these fittings, allowing removal of all scale, welding metal, etc.



The branch line is then welded into position using a simple Vee weld. In the event that a ThredOlet is used the branch pipe is threaded and screwed into place. The result is a junction of full pipe strength, absolutely leak-proof with turbulence and friction reduced to a minimum.

No Cutting - No Threading- No Fitting when WeldOlets and ThredOlets are used

No Cutting—No Threading—No Fitting of the main pipe is necessary when WeldOlets and ThredOlets are used. Branch connections made with these fittings are strong, permanent and absolutely leak-proof. Preliminary layouts of the main pipe and branch are unnecessary. No templetes are used.

Due to their funnel-shaped outlets, WeldOlets and ThredOlets provide free, unrestricted flow. Their heavy, external rib compensates for loss of strength in the main pipe when the hole is cut and distortion is entirely eliminated.

Available from stock with outlet sizes from ½" to 12" for all standard pipe sizes, they are equally well adapted to maintenance work and to new construction, whether indoors or out, above or below ground.

In addition to drop-forged steel in which they are stocked, WeldOlets and ThredOlets can be furnished in Wrought Iron, Toncan Iron, Brass, Monel, Everdur and other metals to meet every piping need.

The illustrations at the left show the ease with which they are installed. Try them at our expense. Sign the coupon below and attach to your company letterhead. It will bring you a sample and complete details.

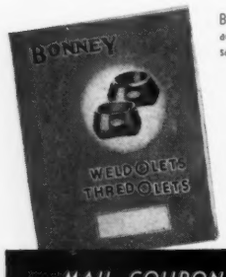
The names "WeldOlets" and "ThredOlets" are Bonney trade-marks registered in the United States Patent Office. Full patent coverage has been granted in the United States and foreign countries.

BONNEY FORGE & TOOL WORKS

Forged Fittings Division

ALLENTOWN, PA.

Stocked by Leading Distributors



Bulletin WT23 tells the complete story about WeldOlets and ThredOlets. The coupon will bring your copy and a sample trial fitting. Mail it today.

Please send me a sample WeldOlet or ThredOlet and a copy of Bulletin WT23 telling all about them. P-18

Name .....

St. & No. .....

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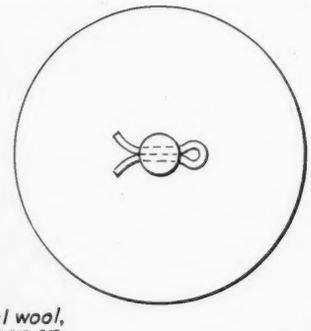
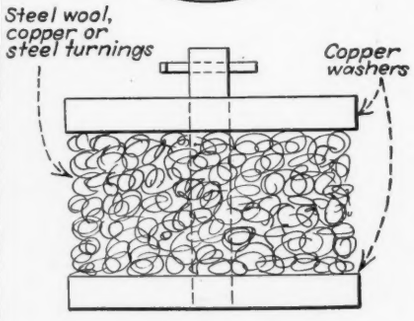
MAIL COUPON TODAY →





The wad-type scraper consists of a copper or soft bronze disk cut 1/32 in. less than inside tube diameter, having a central shank of bronze rod welded in its center. A second copper washer, centrally drilled to slip freely on the bronze shank of the other half of the "wad" was kept from slipping off with a cotter pin through the end of the shank. Either steel wool, copper turnings, or steel turnings, depending upon the toughness of the cleaning job, were wrapped around the spindle and allowed to project beyond the edge of the washer slightly on all sides. The upper washer was then put in place, compressing the metal filling somewhat, and the cotter replaced.

When inserted into the end of a tube and air or steam pressure admitted behind it, the loose disk further compressed the metal shavings, forcing them into close contact with the tube walls and effectively cleaning them. Damage to the plugs through striking the end of the heat exchanger after emerging from the tubes was effectively stopped by a heavy burlap pad. An additional 25% was added to tube life, with an indicated gain of 10% in time intervals between cleanings.

If MCC will try this type of scraper plug on his condenser tubes, he will find negligible loss of tube weight and higher heat-transfer rates than when plastic plugs are used, if not even surpassing results obtained with the steel scraper.

ELTON STERRETT

Longview, Texas

STRAWS (Continued)

Brooks-Skinner Co, Quincy for addition to boiler plant. Cost close to $40,000.

MICHIGAN——**Board of Education, Iron Mountain, plans central-heating plant in 3-story junior high school. Cost about $200,000. F E Parmelee, Iron Mountain, architect.**

Brewster Low-Cost Housing Project, De-

Means Effective POWER Utilization

THERE'S a "long-range" plan for transmitting power from the source to utilization that reflects itself favorably on the production cost records of industry . . . It involves both equipment and methods.

"Planned Power Transmission" must be impartial. No one type of drive can economically meet the varied operating conditions and production requirements of industry — if its *billion dollar bill for power waste is to be materially reduced.*

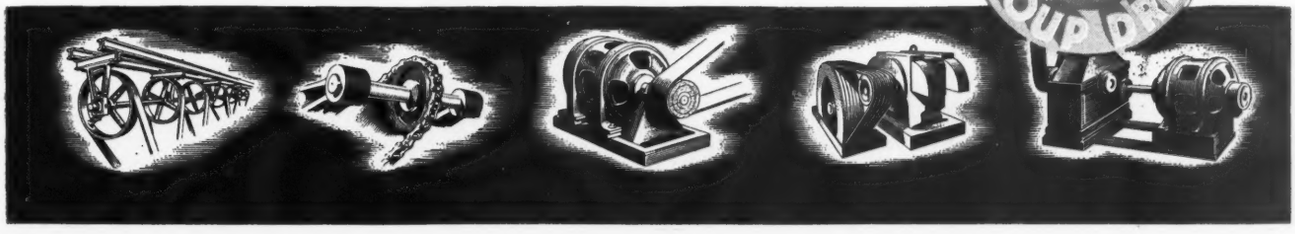
That is why the *Power Transmission Council, Inc.* was formed. In its function, it has surveyed the power-paths of many individual plants and industries. Its engineers—applying the principles of Modern Group Drive fairly and impartially — have effected worth-while economies.

This service entails no charge or obligation. The cost is borne entirely by manufacturers of Power Transmission Equipment as their contribution to greater industrial efficiency. Inquiries are welcomed from any manufacturer.

- ✓ National Organization
- ✓ Sound Engineering
- ✓ Regional Engineers
- ✓ Local Engineering Organizations
- ✓ Effective Merchandising

POWER TRANSMISSION COUNCIL, INC.
75 STATE STREET, BOSTON, MASSACHUSETTS

MODERN GROUP DRIVE PTC



Courtesy of Baldwin-Southwark Corp.

• clearances controlled—
• oil pressure maintained

On this diesel, **LAMINUM** babbitted shims (pat'd) are standard . . . for the important oil pressure control and precision adjustment of main and connecting rod bearing clearances. The same easy accuracy in service adjustments as in assembly! You simply peel off .002 in. (or .003 in.) laminations. Always a clean shim surface! Laminum sample on request.

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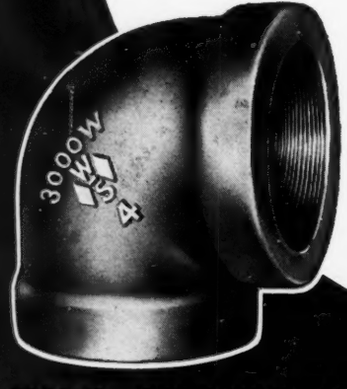
LAMINUM
Precision adjustment **SHIMS**

W-S FORGED STEEL FITTINGS

For complete satisfaction on lines carrying oil, gas, steam, water or ammonia under high pressures and high temperatures, specify W-S Forged Steel Fittings.

They are bored from solid steel forgings, have sharp accurately cut threads and every fitting is carefully inspected and tested.



You will find them definitely stronger, longer lived and more dependable under the most severe conditions.

The better service insured by W-S Fittings is expressed in dollars saved in maintenance.

Write for Bulletin A-3.

THE WATSON-STILLMAN CO.
ROSELLE, N. J.

troit, contracted Robert Gordon, Inc, 19 North Jefferson St, Chicago, for central-steam power house at $213,890.

Water Board, Detroit, contracted Crouse & Saunders, Inc, 415 Brainard St, Detroit, for ventilating equipment and system in pipe vault and laboratory at Springwelts Station, at $18,442.

Bradley Laundry Co, Grand Rapids, plans steam power house in connection with rebuilding of 1-story mechanical laundry plant.

Briggs Mfg Co, 11631 Mack Ave, Detroit, contracted W E Wood Co, 4649 Humboldt St, for steam power house at plant to be erected on Eight-Mile Rd. Cost about $75,000. Giffels & Vallet, Inc, Marquette Bldg, Detroit, architect and engineer.

Hillsdale and W K Kellogg Foundation, Battle Creek, plan central-heating plant in new municipal hospital at Hillsdale. Cost about $175,000.

MINNESOTA——Duluth will award contracts soon for pumping machinery and accessory equipment for group of five new pumping plants in different parts of city for municipal sewage system. Cost about $195,000. J A Farrell, commissioner of public works, in charge.

Wood Conversion Co, Cloquet, plans extensions in power house. Bids scheduled to be asked soon. Ralph D Thomas & Associates, 1200 Second Ave South, Minneapolis, consulting engineers.

Sleepy Eye will award bids soon for extensions in municipal power plant, including diesel generating unit. G M Orr & Co, Baker Arcade Bldg, Minneapolis, consulting engineers.

Theodore Hamm Brewing Co, 681 East Minnehaha St, St. Paul, has approved plans for top story addition to stock house, 48x80 ft, to be equipped as a cold-storage department. Cost about $40,000. C H Johnston, Empire Bank Bldg, St. Paul, architect.

MISSISSIPPI——Ittabena plans installation of a 225-hp diesel-generator unit with fuel-oil storage tank, air compressor, pumping units, etc, in municipal power plant. $50,000 authorized. W A Fuller & Co, 2916 Shenandoah St, St. Louis, Mo., consulting engineers.

MISSOURI——State Building Commission, Capitol Bldg, Jefferson City, plans power house at new prison unit on Boonville Rd. Cost about $900,000. Alonzo H Gentry, Voskamp & Neville, Inc, 4 West Thirteenth St, Kansas City, architect.

Board of Education, Fulton, plans central-heating plant in 2-story-and-basement senior high school. Cost $245,000. Felt & Kriehn, 4638 Mill Creek Parkway, Kansas City, architects.

Bids were opened Dec 28 by University of Missouri, Columbia, for one 300-lb, 50,000-lb-per-hr steam-generating unit, and one 750-kw, 30-lb g exhaust-pressure turbine-generator.

United States Cold Storage Co, 500 E Third St, Kansas City, plans 7-story and basement cold-storage and refrigerating plant at Atlanta, Ga. Facilities will be installed for handling bulk shipments direct from railroad cars, with 26,000 sq ft of platform space, equipped with conveyors, loaders and other mechanical-handling equipment . Cost about $850,000.

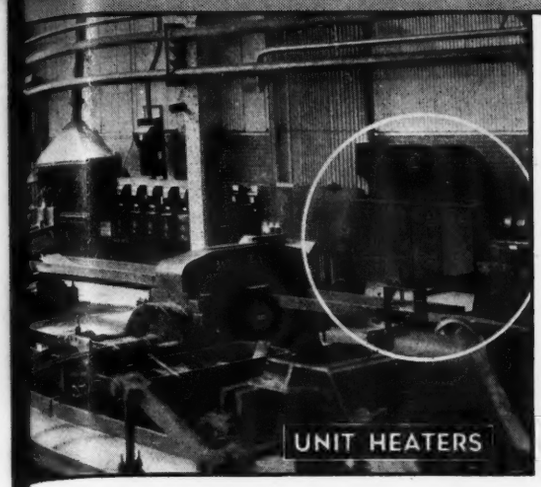
NEBRASKA——Fremont will take bids soon for extensions in municipal power plant, including generating unit, high-pressure boiler, etc. $225,000 arranged. Black & Veatch, 4706 Broadway, Kansas City, Mo., consulting engineers.

Haigler will award contracts soon for two diesel-generator units and auxiliaries for municipal power plant. Cost about $41,000. C Robert Fulton, 2327 South 19th St, Lincoln, consulting engineer.

Blair has authorized purchase of diesel-generator unit for municipal power plant. Cost about $65,000. Black & Veatch, 4706 Broadway, Kansas City, Mo., consulting engineers.

NEW YORK——Cabot Gas Corp, Mt. Read Blvd Rochester, will build 24-in. welded-steel pipeline from Olean to Rochester, for natural-gas transmission. Cost over $200,000.

Buffalo Niagara Electric Corp has dropped



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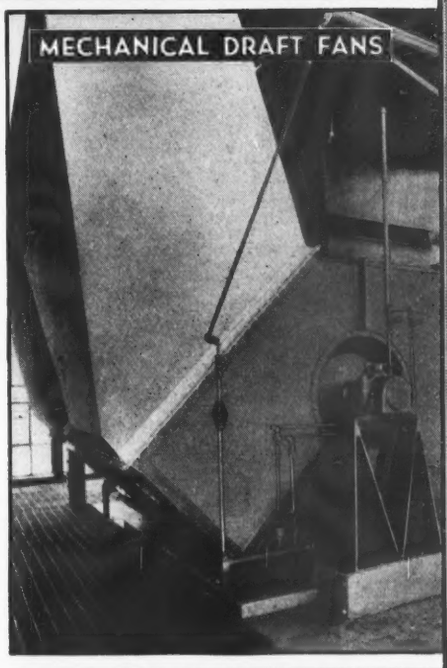

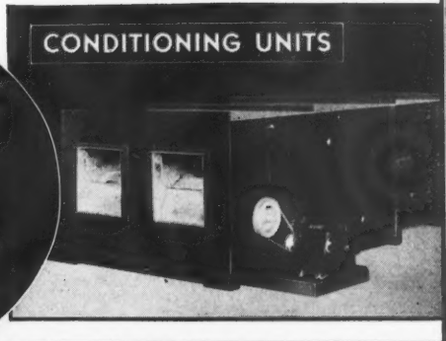

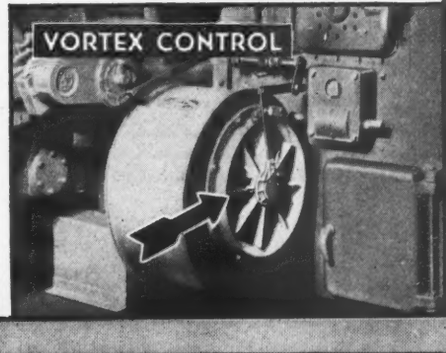

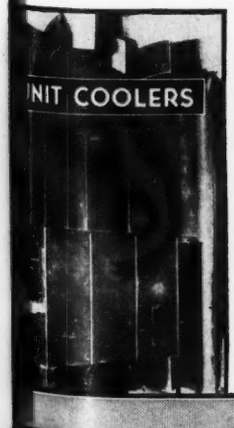

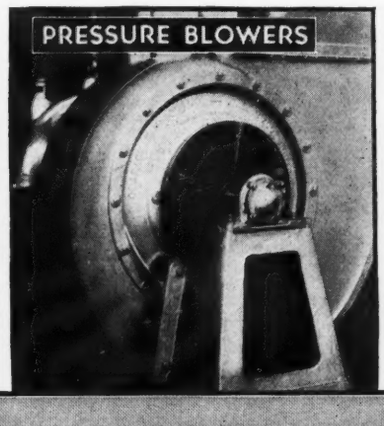

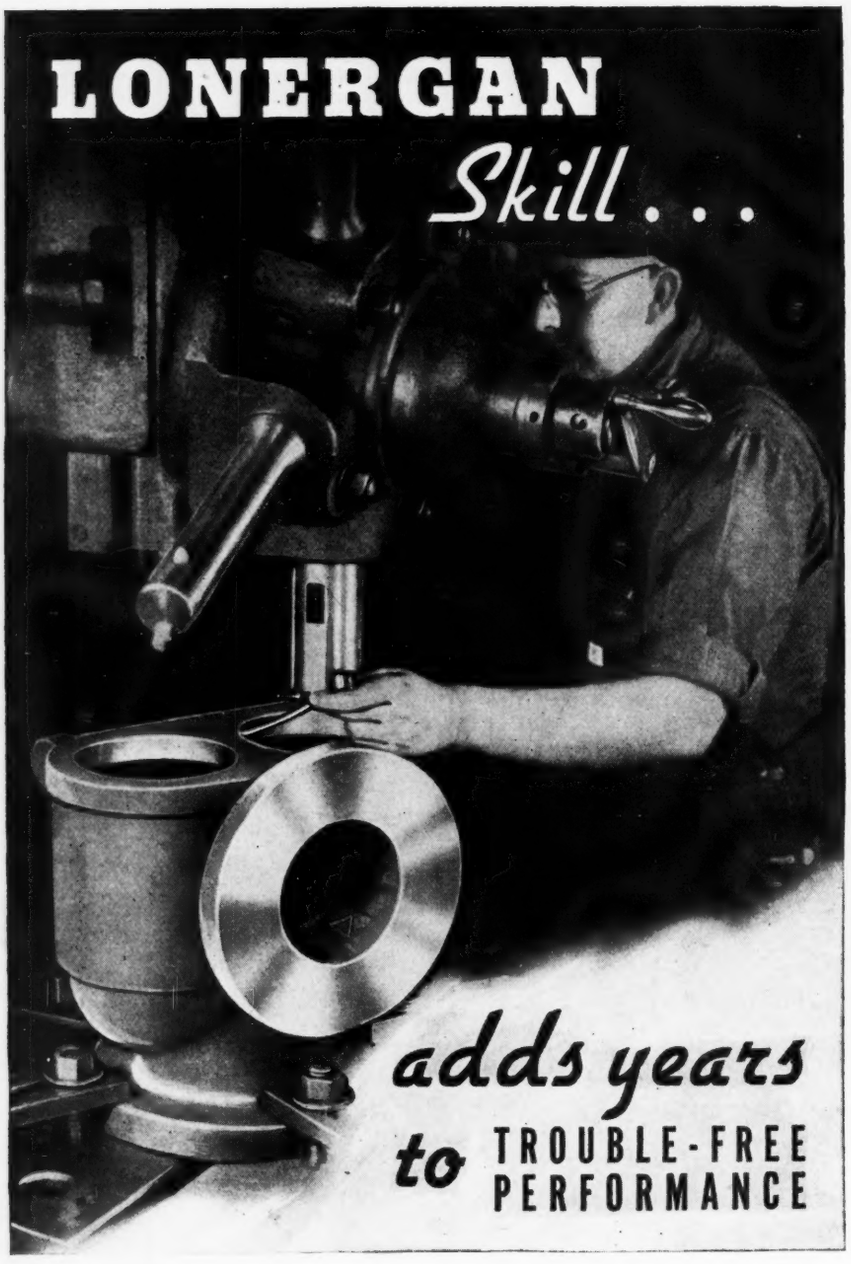

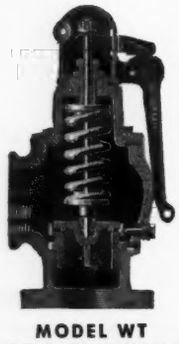

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plans to build new steam-generating plant, planned to cost $8,000,000. William Kelly, president of the company, said that the project had been postponed indefinitely.

OHIO——Columbus plans generating station for public-works department to include two or three gas-engine units, generators, etc. Cost estimated at $225,000. Paul Metzel, City Hall, city engineer.

Water Department, Cincinnati, plans series of electric-operated pumping plants in connection with extensions in waterworks and flood protection system. Cost over $1,000,000.

Newton Falls plans municipal electric plant. $150,000 authorized. D M Bailey, Jr, mayor, in charge.

Standard Oil Co of Ohio, Midland Bank Bldg, Cleveland, contracted Berea Construction Co, same address, for 4- and 6-in. welded-steel pipelines from Latonia, Ky., to Cincinnati. Award for pipe has been given to Republic Steel Corp, Cleveland. Cost close to $100,000.

Nelsonville will make improvements in municipal electric plant. $90,000 authorized. R G Ingelson, 299 Front St, Columbus, consulting engineer.

OKLAHOMA——Waurika plans municipal power plant. Cost about $75,000. Work is scheduled to begin early in 1938.

Texhoma plans municipal gas plant and distributing system. Surveys and estimates of cost being made by Frank E Devlin, W-K-H Bldg, Wichita, consulting engineer.

Board of Education, Ponca City, plans central-heating plant in 2-story junior high school. Cost about $395,000. Winkler & Reid, Oklahoma Savings & Loan Bldg, Oklahoma City, architects.

Fort Cobb plans municipal power plant, with diesel-generator unit and auxiliary equipment. Cost about $30,000.

Warren Petroleum Corp, National Bank of Tulsa Bldg, Tulsa, plans large compressor plant, boiler house and pumping station at new natural gasoline plant in Arkansas oil and gas field area. Arkansas County, Tex. Cost over $250,000.

OREGON——Enterprise Irrigation District, Klamath Falls, has low bid from Brosterhouse Construction Co, Klamath Falls, at $61,999 for construction of dam and power house on Canal of Klamath Reclamation Project, and will award contract soon. B W Short is president.

Salem Box & Mfg Co, Salem, plans boiler house in connection with rebuilding of portion of mill recently destroyed by fire.

TENNESSEE——Lookout Oil & Refining Co, Kirkland Ave, Chattanooga, plans steam power plant in connection with new addition to cottonseed oil mill. Cost close to $115,000.

TEXAS——Rio Foods, Inc, Mercedes, plans boiler house at new local food-canning plant. Cost about $45,000. L F Drake, general manager.

Amsco Refining Corp, Corpus Christi, has authorized 4½-in. welded-steel pipeline from Luby oil-field district, Nueces County, to Clarkwood, Tex., about 12 miles. Cost about $90,000 with booster pumping stations at points along route.

Houston plans central-heating plant in 10-story city hall building, for which bids will be asked soon. Cost about $1,820,000. Joseph Finger, National Standard Bldg, Houston, architect.

Barker & Woods, Houston, oil operators, plan 6-in. welded-steel pipeline from Lisbon oil-field district to Monroe, La., about 47 miles. Cost over $200,000.

Port Arthur Independent School District, Port Arthur, plans central-heating plant in new 2- and 3-story Woodrow Wilson junior high school. Cost about $500,000. Mark Lemmon, Tower Petroleum Bldg, Dallas, architect.

Roegelwein Packing Co, Brazos St, San Antonio, plans 1-story and basement cold-storage and refrigerating plant. Cost over $80,000. H Peter Henschien & Co, 59E Van Buren St, Chicago, architects and engineers; W E Simpson Co, Milam Bldg, San Antonio, consulting engineer.

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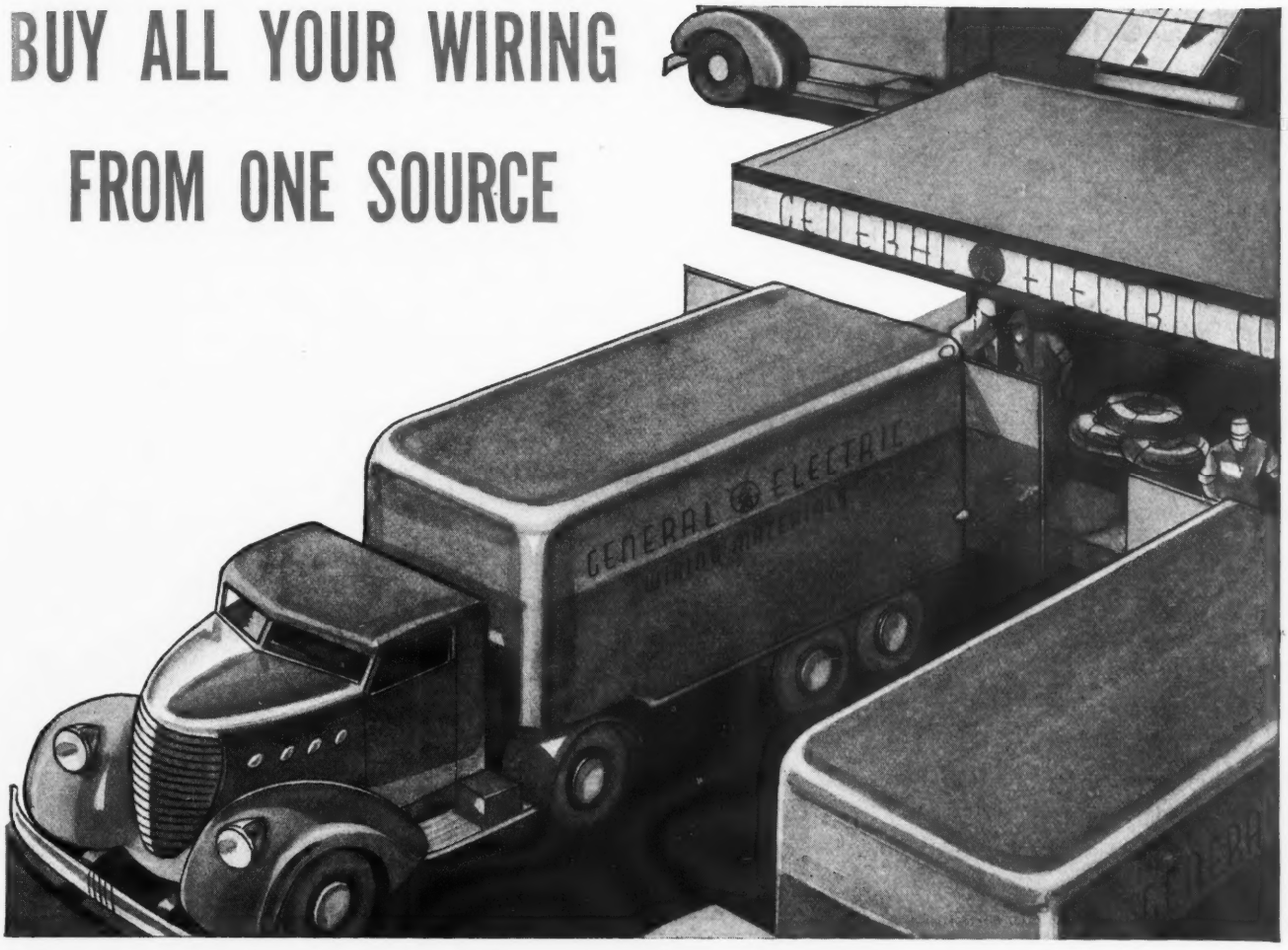

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NEW BULLETINS

BOILERS & ACCESSORIES

1 GAS-FIRED BOILER—Kisco Boiler & Engrg Co, 4333-35 Duncan Ave, St. Louis, Mo. Bulletin CG-337 illustrates and explains operation of gas-fired boiler.

2 STEAM-CONDUIT SYSTEM—H W Porter & Co, Inc. 6-page bulletin presents five steps: (1) pouring the base, (2) placing the pipe supports, (3) installing the piping, (4) insulating the piping, and (5) installing the tile. Drawings show how system is put together.

3 BAFFLE WALLS—The Engineer Co, 17 Battery Place, New York, N. Y. 16-page Bulletin B-37, "The Construction and Application of Enco Baffle Walls to Modern Boilers". Cross-sections show application of baffles to different types of boilers.

INSTRUMENTS & CONTROL

4 FEEDWATER REGULATOR—Northern Equipt Co, Erie, Pa. 8-page bulletin No. 409-A describes Copes "Flowmatic Regulator", a 2-element automatic boiler-feedwater regulator. 3-color sectional views show operation of regulator with both direct-operated and hydraulically-operated valve.

5 FLOWMETERS—Bristol Co, Waterbury, Conn. Bulletin 494 illustrates applications and outlines features of new electric flowmeter.

6 FLOWMETERS—Foxboro Co, Foxboro, Mass. 4-page bulletin DMF-726 describes special instruments for high-pressure measurement. Sectional views show operation and construction.

7 INSTRUMENTS—Foxboro Co, Foxboro, Mass. 16-page folder contains illustrations of more than 20 instruments. Separate sections discuss thermometers, pyrometers, controllers for pressure, temperature and flow, electric controllers, flowmeters, flow controllers, humidity instruments and tachometers.

8 PYROMETERS—Bristol Co, Waterbury, Conn. Illustrated bulletin No. 493 describes newly developed potentiometer, which can be used as a pyrometer, resistance thermometer, a tachometer, and a millivoltmeter. Also briefly described are wide-strip single and multiple recorders, and recording controllers.

9 INSTRUMENTS—Hays Corp, Michigan City, Ind. Three Bulletins: No. 37-294 on draft gages, No. 37-297 on combustion meters, and No. 105 on combustion regulators. Extensively illustrated with photos and line drawings to show operation, construction and applications.

10 INSTRUMENTS—Leeds & Northrup Co, 4934 Stenton Ave, Philadelphia, Pa. 32-page Catalog N-33-163 shows how temperature measurements help to effect important operating economies, describes three methods of measurement, and presents Micromax indicators, recorders, controllers and accessories.

11 THERMOMETERS—C J Tagliabue Mfg Co, Park & Nostrand Aves, Brooklyn, N. Y. 24-page catalog No. 1125B lists complete line of TAG industrial thermometers, showing construction, forms and connections. Also miscellaneous thermometers, including metal and wood back, cup case, etc. Also describes hygrometers, U-gages, mercurial vacuum gages and mercurial barometers.

ELECTRICAL EQUIPMENT

12 FRACTIONAL-HP MOTORS—Century Electric Co, 1806 Pine St, St. Louis, Mo. 24-page Bulletin 1039 presents information on electrical characteristics of fractional-hp motors, and describes several types of these motors in detail.

13 MOTORS—Fairbanks, Morse & Co, 900 S Wabash Ave, Chicago, Ill. 4-page

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MOTOR CONTROLS

bulletin No. 1410 on vertical hollow- and solid-shaft polyphase, ball-bearing, squirrel-cage, induction motors. Describes construction in detail.

14 CAPACITORS—Cornell-Dubilier Elect Corp, South Plainfield, N. J. Catalog 142 describes and illustrates various mounting and constructional features of box-type capacitors for correction of low-power factor in industrial plants.

15 REMOTE-CONTROL SWITCHES—Automatic Switch Co, 154 Grand St, New York, N. Y. Bulletin 920A on remote-control swtiches is profusely illustrated with drawings and photos showing details of operation, performance, advantages, etc.

16 MOTORS—General Electric Co, Schenectady, N. Y. 4-page Bulletin GEA-1368C shows vertical hollow-shaft induction motors, construction, application, and advantages. Photos and line drawings.

17 WELDERS—Hobart Brothers Co, Troy, Ohio. 24-page catalog describes welding with new 40-volt simplified arc welder. Many illustrations on uses.

WATER TREATMENT

18 WATER TREATMENT—Dudley K French & Associates, 6025 W 66th Place, Chicago, Ill. 4-page bulletin F1 describes a laboratory service for water treatment. After making an analysis, directions and prescriptions for the removal of causes of impure-water troubles are submitted to the plant engineer.

19 WATER TREATMENT—National Aluminate Corp, 6216 W 66th Place, Chicago, Ill. Three bulletins. "Nalco Softening Plant Systems" shows equipment and installations; "Nalco A B System" on boiler-water treatment; and "Nalco Internal Treatment System" describes method of treating feed water in the boiler.

20 WATER TREATMENT—Bird-Archer Co, 122 S Michigan Ave, Chicago, Ill. 42-page booklet, "50 Years of Notable Contributions to Scientific Boiler-Water Treatments" discusses water-treatment field, methods, etc.

MECHANICAL TRANSMISSION

21 BEARINGS—New Departure Div, General Motors Corp, Bristol, Conn. 20-page Booklet D gives principles involved in New Departure "Seal Bearing". Numerous case histories are cited and illustrated in which these bearings have been used.

22 MECHANICAL-TRANSMISSION EQUIPMENT—Boston Gear Works, Inc, North Quincy, Mass. Folder D-1 describes non-metallic motor-pinion drives and gives tables of dimensions, prices, possible ratios, etc. Illustrated Catalog 101 lists "Ratiomotors" (for motorized speed reducers) and "Reductors" (for speed reducers).

23 COUPLINGS—Bartlett Hayward Div, Koppers Co, Baltimore, Md. 40-page catalog, well illustrated with photos and line drawings, describes operation and application of a number of self-aligning couplings. Rating tables included.

24 HYDRAULIC COUPLING—Hydraulic Coupling Div, American Blower Corp, Detroit, Mich. 8-page bulletin describes installation of hydraulic coupling on dragline excavators.

25 FLEXIBLE COUPLING — American Metal Hose Branch, American Brass Co, Waterbury, Conn. 16-page Bulletin SS-3 gives essentials of construction, applications, typical installations, fittings and specifications.

26 AIR-CONDITIONING INSTRUMENTS —Julien P Friez & Sons, Inc, Baltimore, Md. 8-page Catalog K contains illustrations, brief descriptions, and list prices of range of instruments for automatic controlling, indicating, recording, testing and measuring of air conditions.

27 STEAM-HEATING SPECIALTIES—Trane Co, LaCrosse, Wis. 36-page catalog No. V260 includes data on vapor-heating system, split systems, vacuum systems, and heat-loss calculations; illustrates and describes typical piping connections; and suggests what valve, what trap, what vent goes where and under what conditions for best results.

28 WATER-SPRAY NOZZLES—Monarch Mfg Works, Inc, Salmon & Westmoreland Sts, Philadelphia, Pa. Catalog 6-A lists capacities and prices on air-conditioning sprays, air-washing sprays, ash quenchers, flat-spray nozzles, and recooling sprays.

29 DUST COLLECTORS—C O Bartlett & Snow Co, Cleveland, Ohio. 36-page bulletin No. 79, "Wet Dust Collectors", describes oil-froth unit which eliminate dust in the form of a water-wet sludge. Complete description of various units plus technical data on friction losses, etc.

METALS

30 ALLOYS AND METALS—Haynes Stellite Co, Kokomo, Ind. "Haynes Stellite Library", lists and briefly describes 18 books, reprints, and folders dealing with hard-facing alloys, cutting tools, and alloys for chemical-processing equipment.

31 ALLOYS—International Nickel Co, Inc, 67 Wall St, New York, N. Y. T-13 gives technical information on nickel and nickel-base alloys, and their use in the design of corrosion-resistant machinery and equipment. Bulletin T-14 presents technical information on design and construction of heavy equipment in Monel, nickel and Inconel.

32 HIGH-TEMPERATURE STEELS — Timken Roller Bearing Co, Canton, Ohio. Technical bulletin No. 20 presents in tabular form various characteristics such as creep strength, oxidation resistance, rupture strength, etc, for several steels. Also booklet "Digest of Steels for High Temperature Service" gives more complete information.

33 WROUGHT IRON—A M Byers Co, Pittsburgh, Pa. 32-page illustrated bulletin, "101 Uses for Wrought Iron" contains more than 100 photos showing uses. Some photos represent new construction, some are maintenance replacements, and others show where wrought iron has been embodied in a finished product.

34 CENTRIFUGAL PUMPS — Dayton-Dowd Co, Quincy, Ill. Bulletin 805 on Type D close-coupled centrifugal pumps. Cross sections, dimensions and rating tables, and friction head-loss table.

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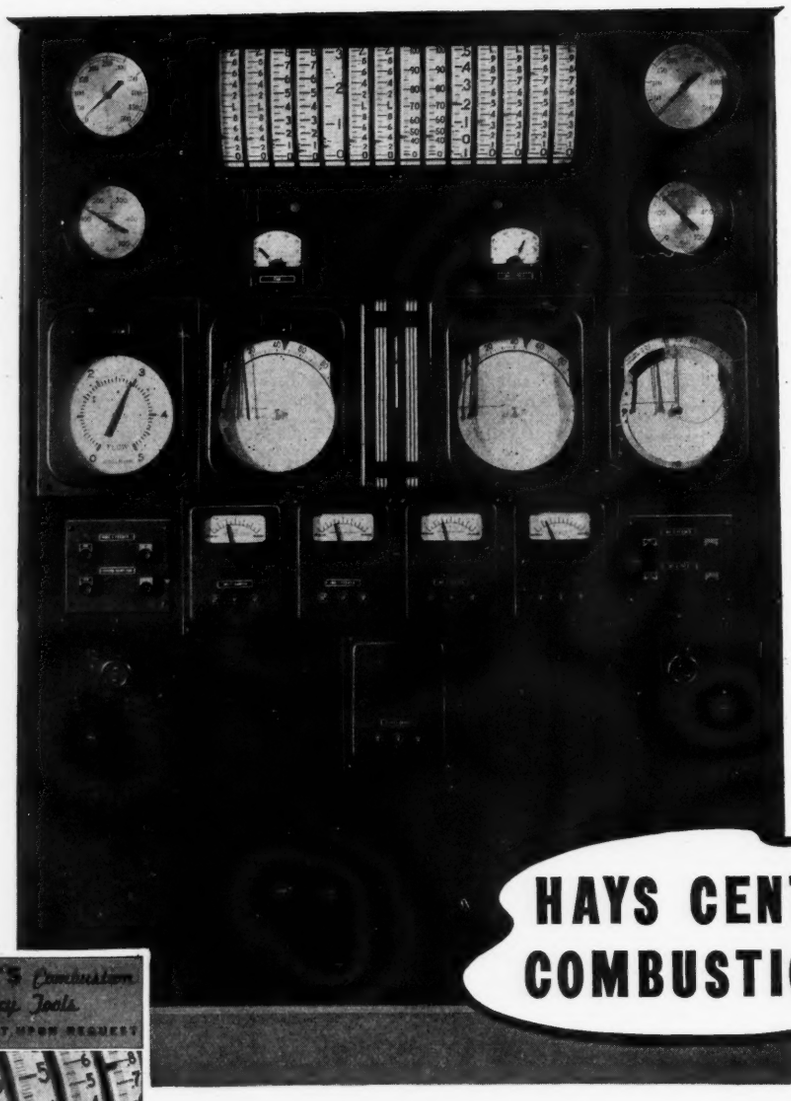

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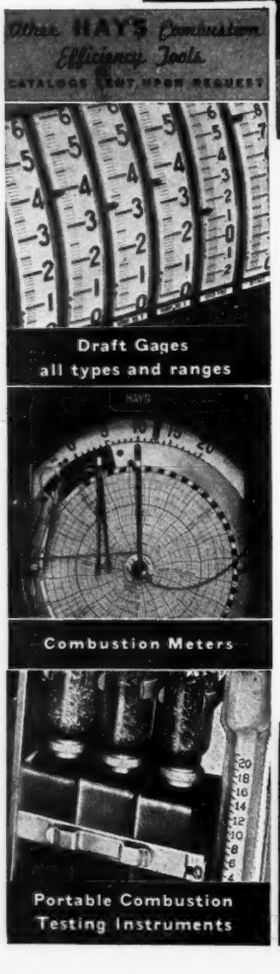

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